THE PRODUCTION ENGINEER

THE JOURNAL OF THE INSTITUTION OF PRODUCTION ENGINEERS

DECEMBER 1961

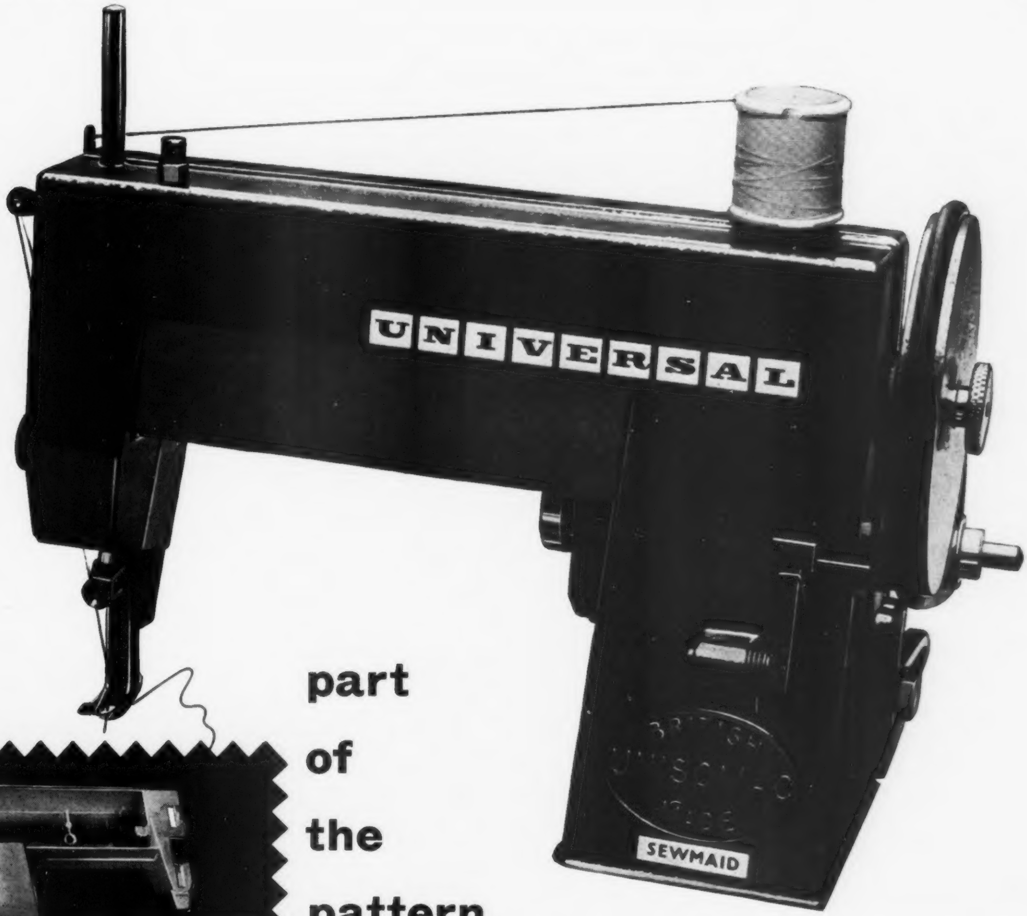
THE PRODUCTION ENGINEER

VOL. 40 - No. 12 PRICE 10/- DECEMBER 1961

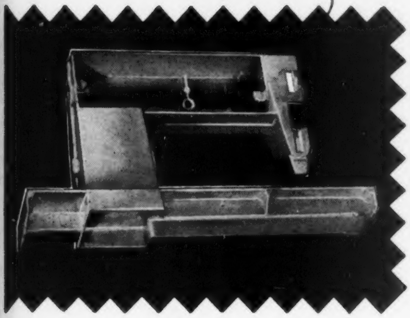
CONTENTS

THE JOURNAL OF
THE INSTITUTION OF
PRODUCTION ENGINEERS

10 Chesterfield Street
Mayfair : London : W.1
Telephone GROsvenor 5254-9



part of the pattern



Body and base plate pressure die cast complete as one unit in aluminium alloy for Universal Sewing Machines Ltd

THE SEWING MACHINE . . .
a recurring feature of the British domestic scene.
And like countless other worthwhile products
it embodies castings made by Birmal.
Dependable Birmal! As necessary in their way
as stitches in a well made garment,
and as seldom in the public eye.
For more than 50 years Birmal skill has set the pattern
for so many first class castings . . .
in sewing machines and motor cars,
in nuclear engineering and aeroplanes.
And for many years to come,
Birmal will continue to be relied on
wherever the quality of castings counts.

BIRMAL

Birmingham Aluminium Casting (1903) Co. Ltd

BIRMID WORKS SMETHWICK 40 STAFFS

THE FIRST AEROSOL FOR CUTTING LUBRICATION!

Entirely new practical ideas which work are all too rare and it is therefore with particular satisfaction that we are now able to introduce you to Rocol R.T.D. Spray. For the first time, the efficiency of Rocol R.T.D. Compound is combined with the advantages of an aerosol Spray and full details of the many benefits to be obtained are set out in the leaflet enclosed in this issue of "Production Engineer".

Rocol R.T.D. Spray has already been employed in a wide variety of practical tests which have demonstrated the efficiency of application. Similar practical tests of R.T.D. Spray will convince *you* of its merits.

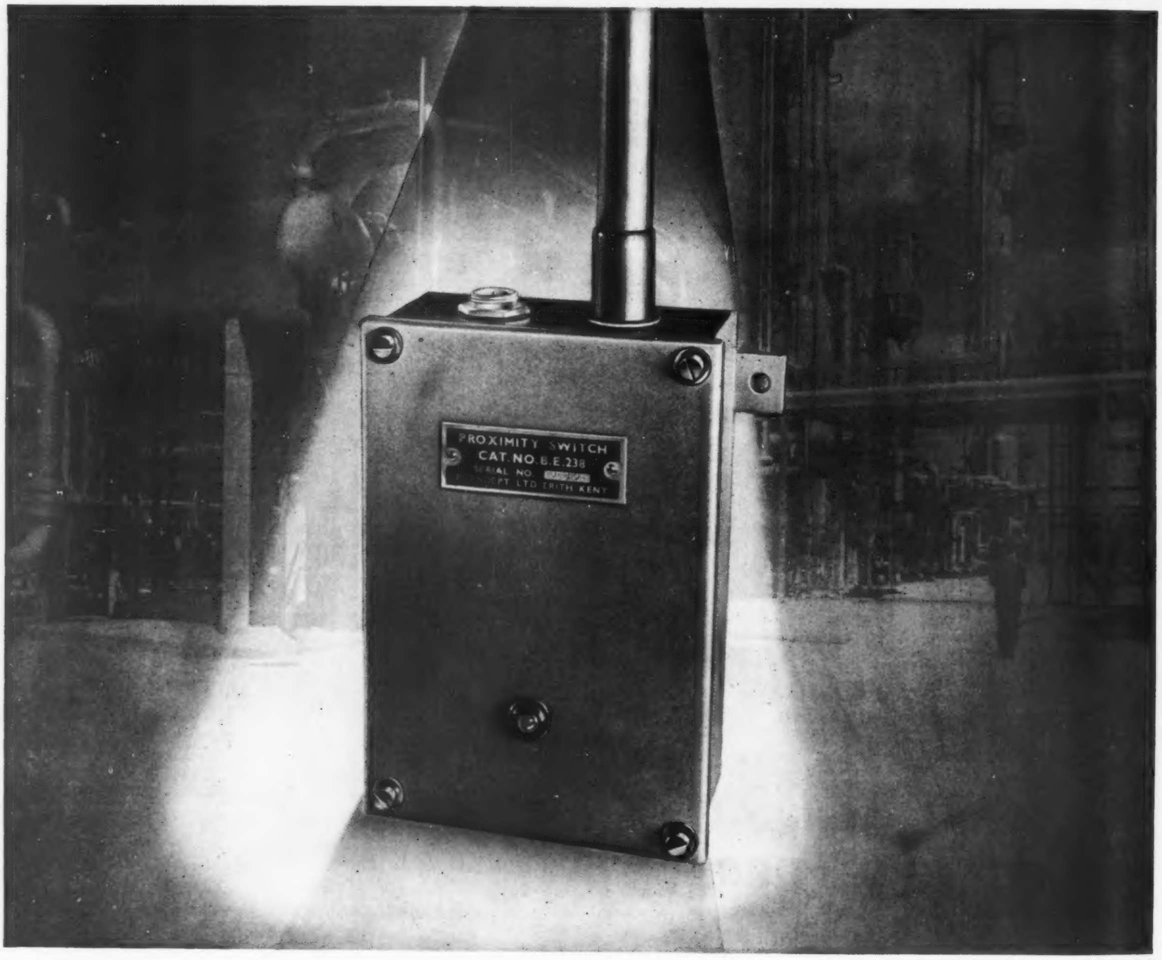
Supplies can be obtained direct from this office or through your local stockist.

For further copies of the R.T.D. Spray or R.T.D. Compound leaflets, or for any other information, please write or 'phone.

Rocol Limited

General Buildings, Aldwych, London, W.C.2. Tel: HOLborn 1985
Rocol House, Swillington, Near Leeds. Tel: Garforth 2261.

ELECTRONIC INSTRUMENTATION PIONEERED AND PERFECTED BY BURNDEPT



Background: an Esso photograph

CONTROL...minus the HUMAN FACTOR SPOTLIGHT ON PROXIMITY SWITCH BE.238

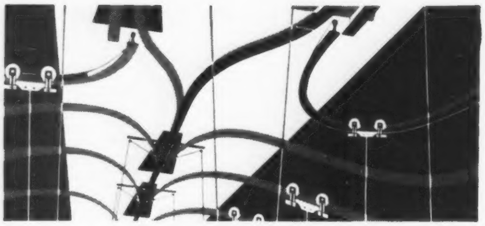
ELECTRONICS
BURNDEPT
NUCLEONICS

Operating upon changes in capacitance as low as 0·05 pf, this Burndept Proximity Switch provides extremely sensitive control of temperature, level, counting, process initiation and innumerable other applications. The sensing probe will detect any object in its vicinity without physical contact. Given a sufficient change in contour, it will even sense objects touching each other, requiring only a probe on one side of a conveyor belt, thus overcoming an inherent drawback of photo-electric methods. Furthermore, it will provide accurate level control of powders, fluids or granules, either electrically conducting or non-conducting.

The switch will operate continuously under adverse industrial conditions and is not affected by dust, moisture or vibration If necessary, it can be supplied in a flame or explosion proof enclosure. A wide range of standard sensing probes is available, and probes can be designed to suit special requirements. A 6-ft low capacity, high stability co-axial cable is provided. There are two alternative terminations to suit particular probes, and armoured versions of both types are available. A Matching Unit can be used, allowing lead lengths up to 58 ft. between sensing probe and main unit.

ENQUIRIES WELCOME: INDUSTRIAL ELECTRONICS DIVISION · **BURNDEPT LTD** · ERITH · KENT · TEL: ERITH 33080

20,000 square feet of extra space



MonoRail Overhead Handling Systems can double your effective factory area by using free space overhead for moving and lifting operations. Track, interlocks and bridges are all available to give you an overhead system tailor-made for your needs. Installations range from complex automated systems to simple gravity drives. Get *your* handling problems off the factory floor. Look into MonoRail now.

'OVERHEAD'

says the man with the MONORAIL plan

UNDERSLUNG CRANES, AUTOMATIC MONORAIL SYSTEMS, DIP SECTIONS, WEIGH SECTIONS, KANT SHOCK SHIELDED ELECTRIFICATION

Send for the man with the MONORAIL plan

BRITISH MONORAIL LIMITED WAKEFIELD ROAD BRIGHOUSE YORKS TELEPHONE BRIGHOUSE 2244

A Member of the Herbert Morris Group of Companies

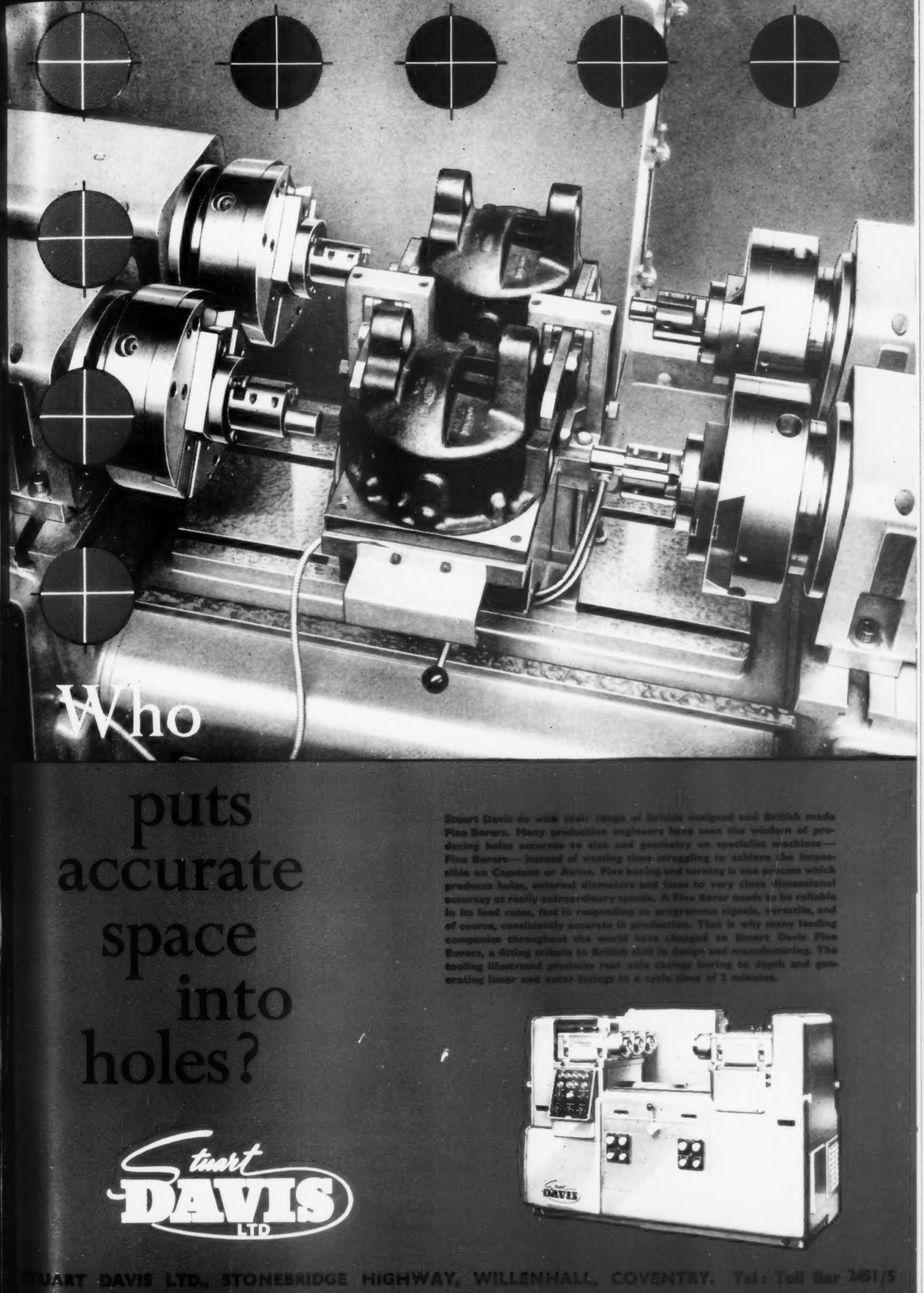
TGA BM13

eer

ve
ng
ou
ge
ur
w.

n

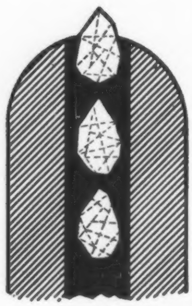
n
14


Who
puts
accurate
space
into
holes?
Stuart Davis do with their range of British designed and British made Fine Borers. Many production engineers have seen the wisdom of producing holes accurate to size and geometry on specialist machines—Fine Borers—instead of wasting time struggling to achieve the impossible on Capstans or Autos. Fine boring and turning is one process which produces holes, external diameters and faces to very close dimensional accuracy at really extraordinary speeds. A Fine Borer needs to be reliable in its feed rates, fast in responding to programme signals, versatile, and of course, consistently accurate in production. That is why many leading companies throughout the world have changed to Stuart Davis Fine Borers, a fitting tribute to British skill in design and manufacturing. The tooling illustrated produces rear axle casings boring to depth and generating inner and outer facings in a cycle time of 2 minutes.
Stuart DAVIS LTD
STUART DAVIS LTD., STONEBRIDGE HIGHWAY, WILLENHALL, COVENTRY. Tel: Toll Bar 2451/5

KNOW YOUR DIAMOND

Physical properties

Properly applied, diamond is the supreme cutting material because it is the hardest substance known. It is about five times as hard as tungsten carbide or corundum, and this property is derived from the enormously high temperatures and pressures under which it is formed. The use of diamond for cutting purposes, however, poses special problems, since its strength does not match its hardness. Tensile strength, clearly, is unimportant in this context, but the low compressive strength demands that diamond tools be carefully handled, while adequate support of the stone is necessary to counter the relative weakness in shear.

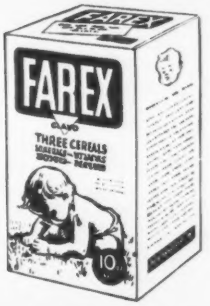


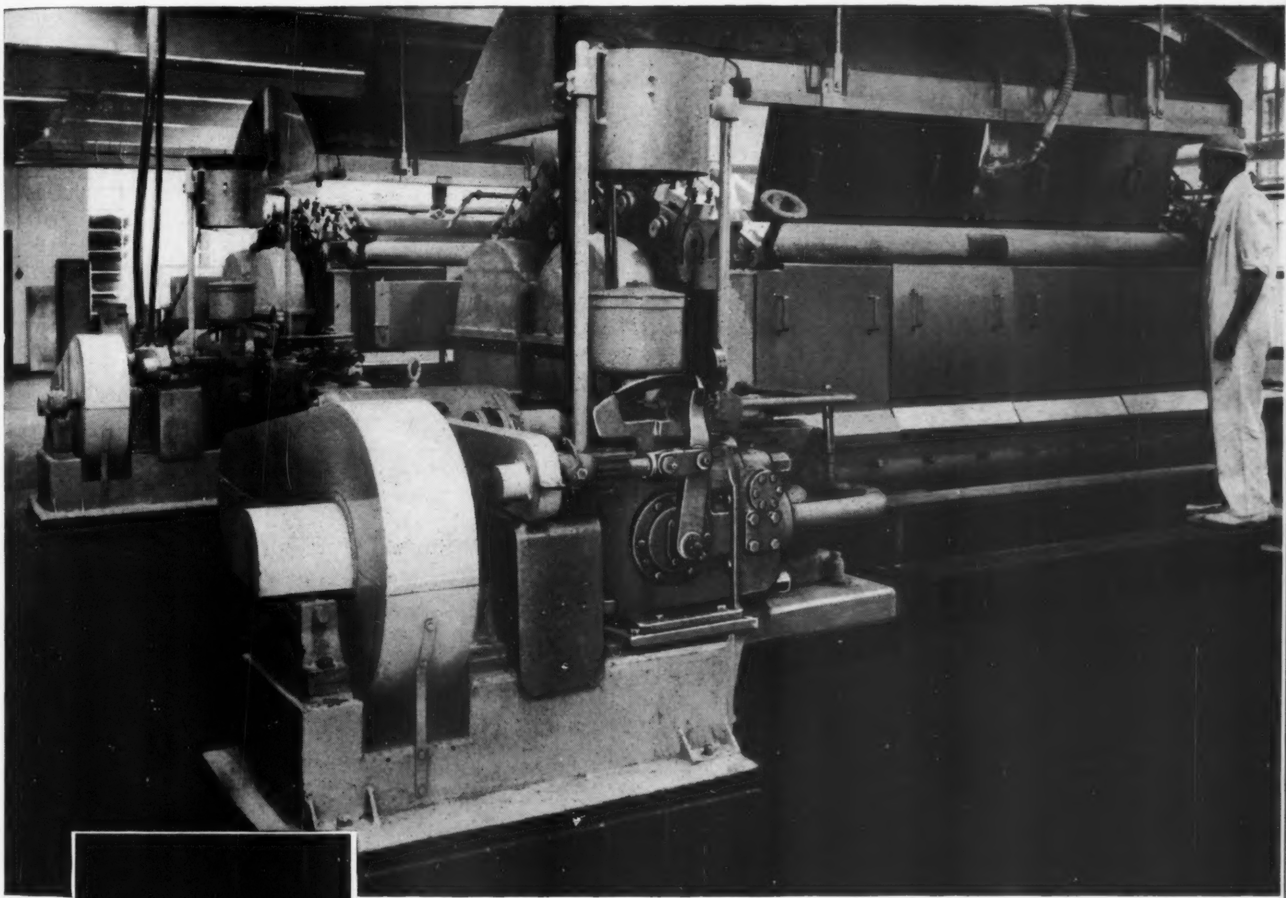
Data sheets available

L.M. VAN MOPPES & SONS (DIAMOND TOOLS) LTD
BASINGSTOKE · HAMPSHIRE · ENGLAND

TELEPHONE: BASINGSTOKE 1240 TELEGRAMS: DIATIPT, BASINGSTOKE

HYDRAULICS serve the very young...





VSG Mark III Hydraulic Transmission Gears capable of 50 H.P. output driving Richard Simons & Sons Ltd., twin cylinder drying machines in the Farex Dept. at Glaxo Laboratories Ltd., Greenford, Middx.

INFINITELY VARIABLE HYDRAULIC TRANSMISSION GEARS

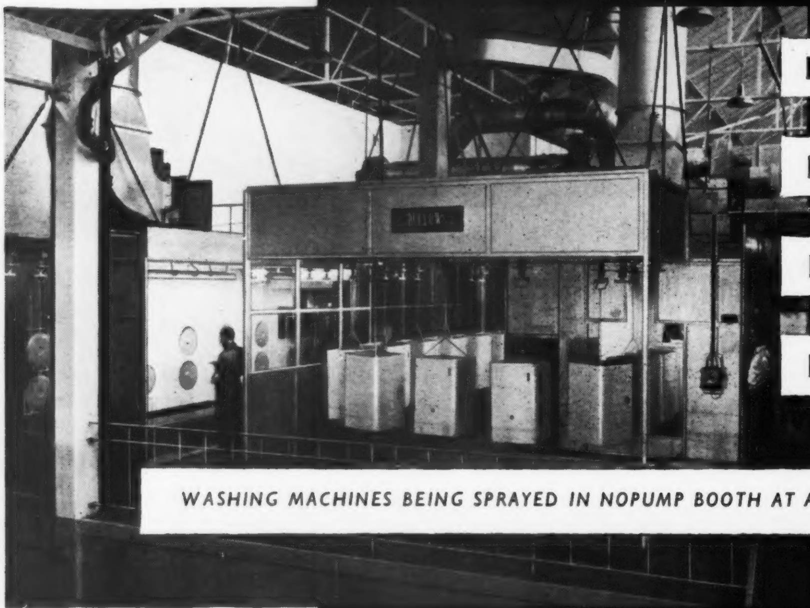
VICKERS-ARMSTRONGS (ENGINEERS) LTD

HYDRAULICS DIVISION WEYMOUTH WORKS WEYMOUTH DORSET Tel: Weymouth 6

Further Technical Information Supplied on request to

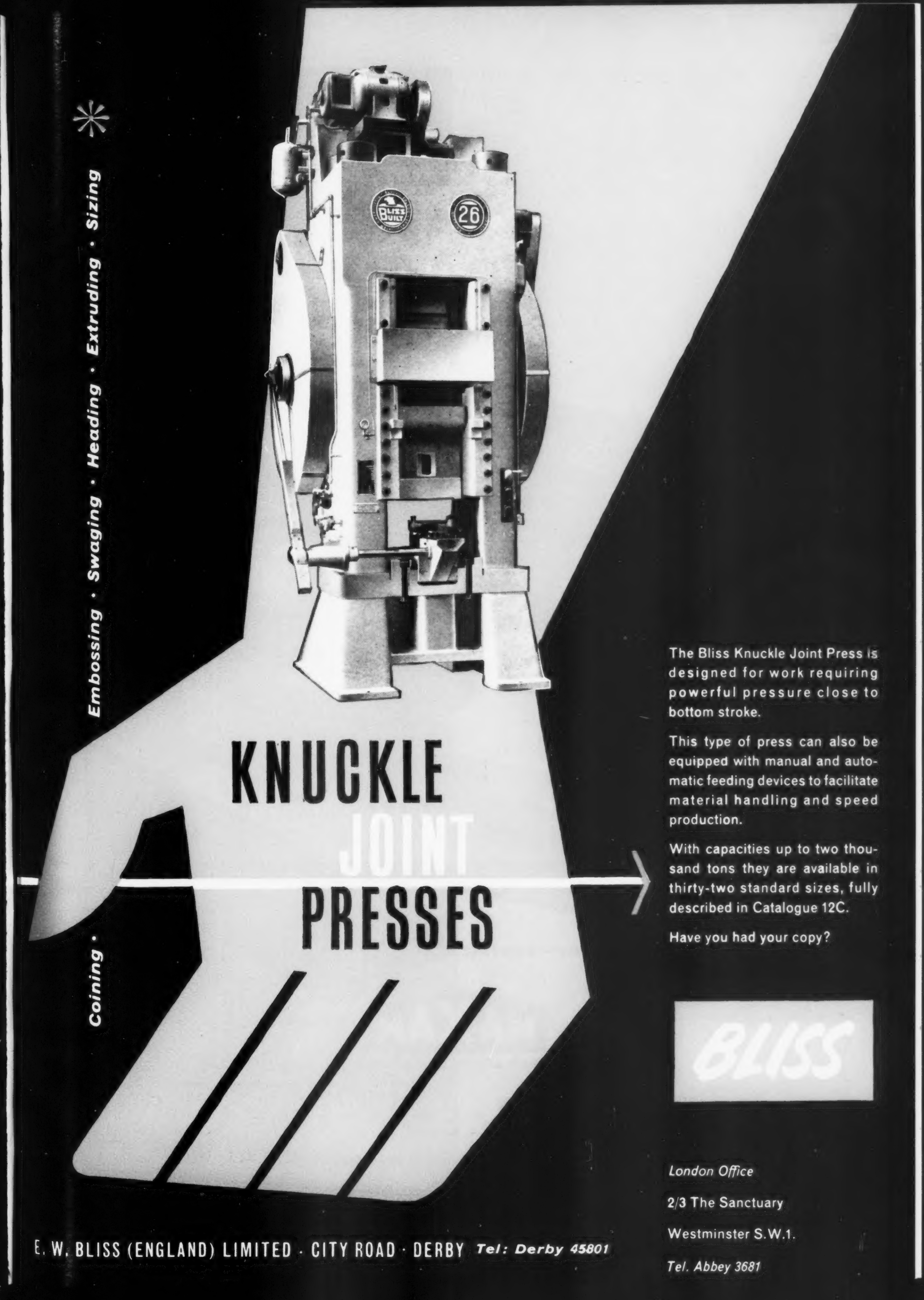
Registered Offices and Sales Department: VICKERS HOUSE BROADWAY LONDON SW1 Tel: ABBEY 7777

34C



gineer

H-W.66


Coining · Embossing · Swaging · Heading · Extruding · Sizing
KNUCKLE
JOINT
PRESSES
The Bliss Knuckle Joint Press is designed for work requiring powerful pressure close to bottom stroke.
This type of press can also be equipped with manual and automatic feeding devices to facilitate material handling and speed production.
With capacities up to two thousand tons they are available in thirty-two standard sizes, fully described in Catalogue 12C.
Have you had your copy?
BLISS
London Office
2/3 The Sanctuary
Westminster S.W.1.
Tel. Abbey 3681
E. W. BLISS (ENGLAND) LIMITED · CITY ROAD · DERBY Tel: Derby 45801


Kodak
Kodak Tri-X Pan Film TX 120
Kodak Tri-X Pan
FAST BLACK-AND-WHITE FILM
Kodak
Kodachrome
COLOUR REVERSAL
Kodak
Kodacolor
COLOUR NEGATIVE FILM
C 120
Kodak
Kodak Verichrome Pan Film VP 120
Kodak Verichrome Pan

MAXAM FLUID POWER

Millions of Kodak films are made with the aid of MAXAM equipment

Popularity of KODAK films dictates the need for continuous high-speed production at the Harrow factory of Kodak Ltd.

Continuity of production depends on the use of reliable, first-class equipment. MAXAM cylinders, valves, and other pneumatic equipment help in the manufacture, and packaging of Kodak's famous branded products.

Wherever the efficient and uninterrupted operation of production lines depends on the constant use of compressed air, production engineers specify MAXAM Fluid Power Equipment.

outset—to last!

MAXAM

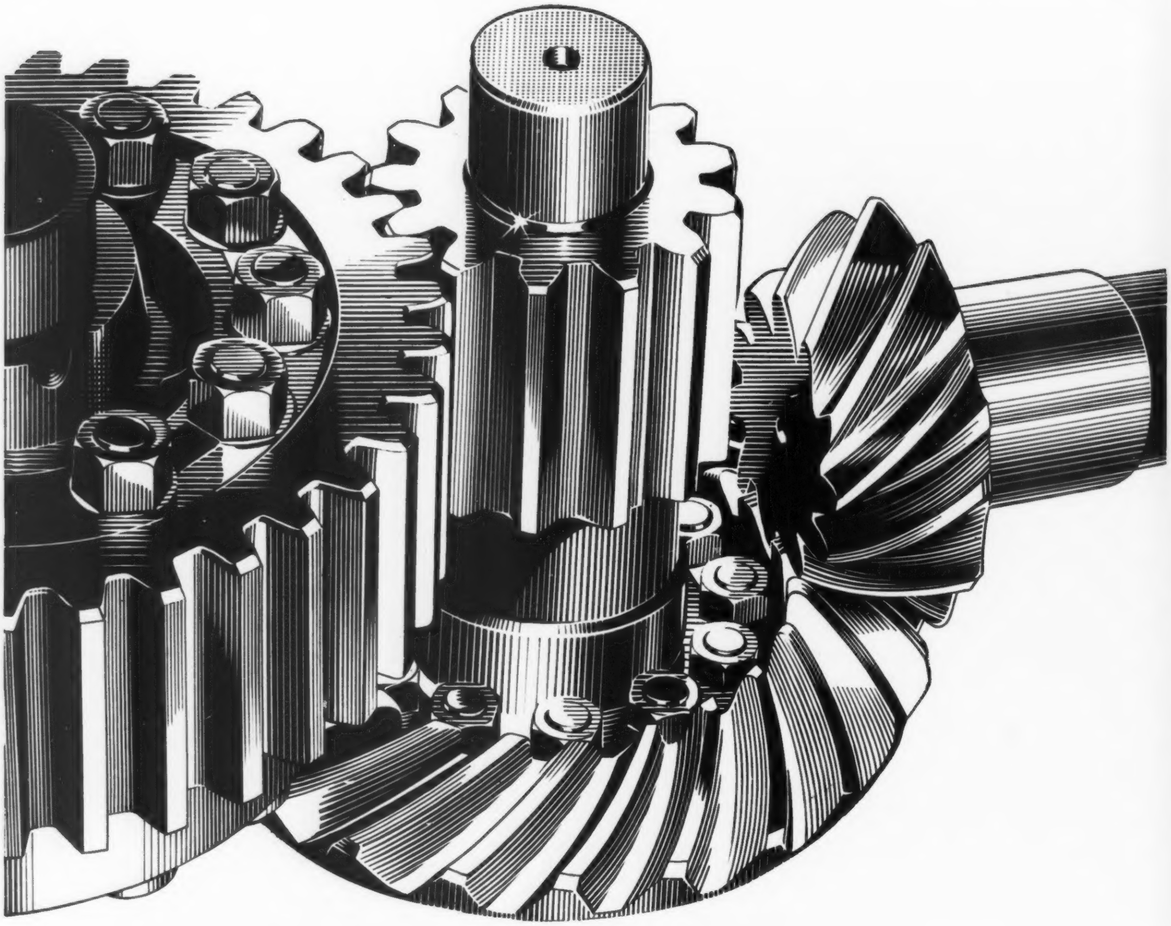
TRADE MARK

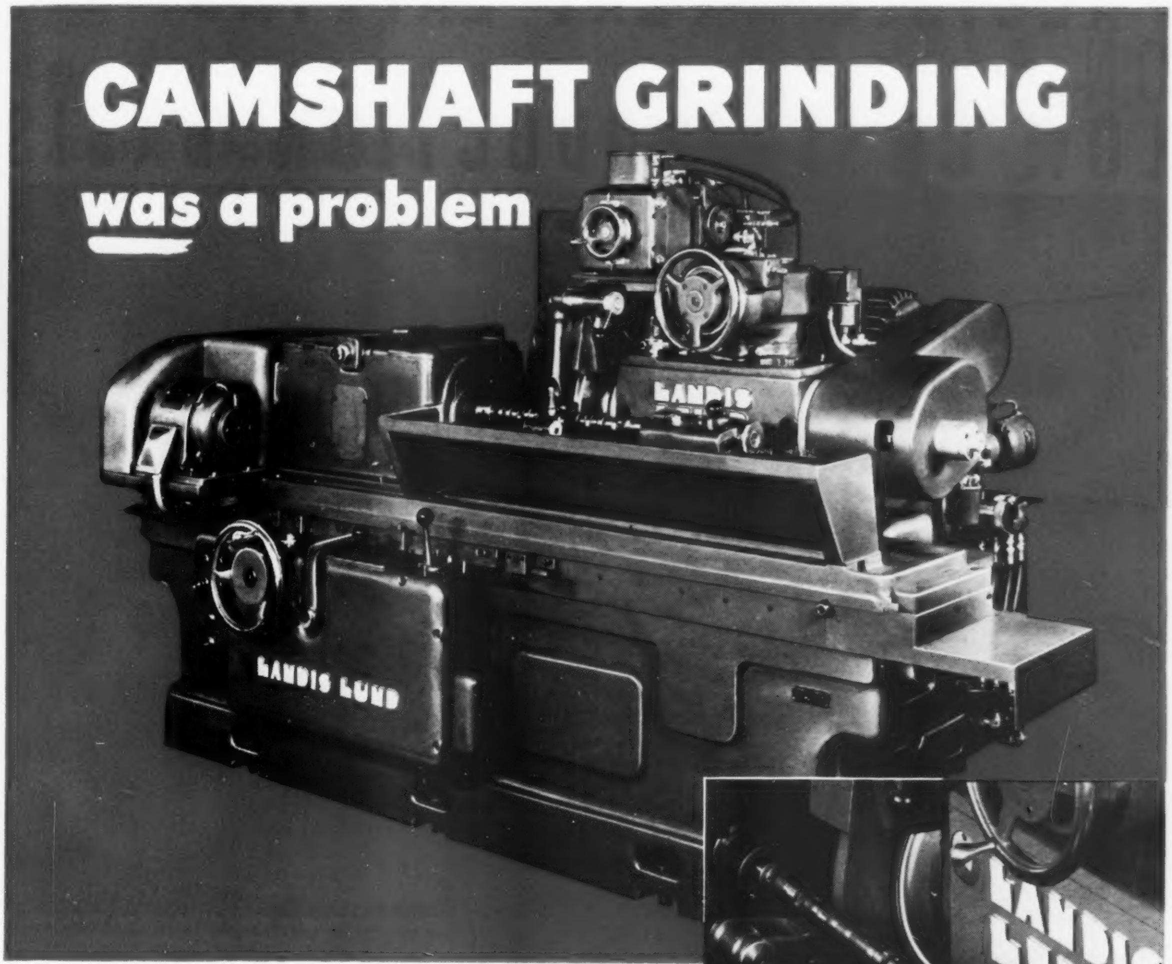
Maxam Power Limited, Camborne, England: Camborne 2275 and 44 Brook Street, London W.1: HYDe Park 9444

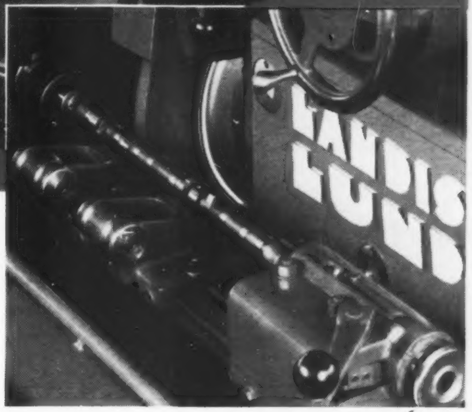
Also in Birmingham · Bristol · Cardiff · Glasgow · Peterborough Sheffield. Australia · Canada · East Africa · France · India Rhodesia and Nyasaland · South Africa · Spain · U.S.A. West Africa

With Agents and Representatives throughout the world

THE HOLMAN GROUP







But Not Any More!

Tailored to the job of camshaft grinding — that's the Landis-Lund type DH machine.

The principles used in this machine have proved themselves over long periods in leading automobile plants throughout the world.

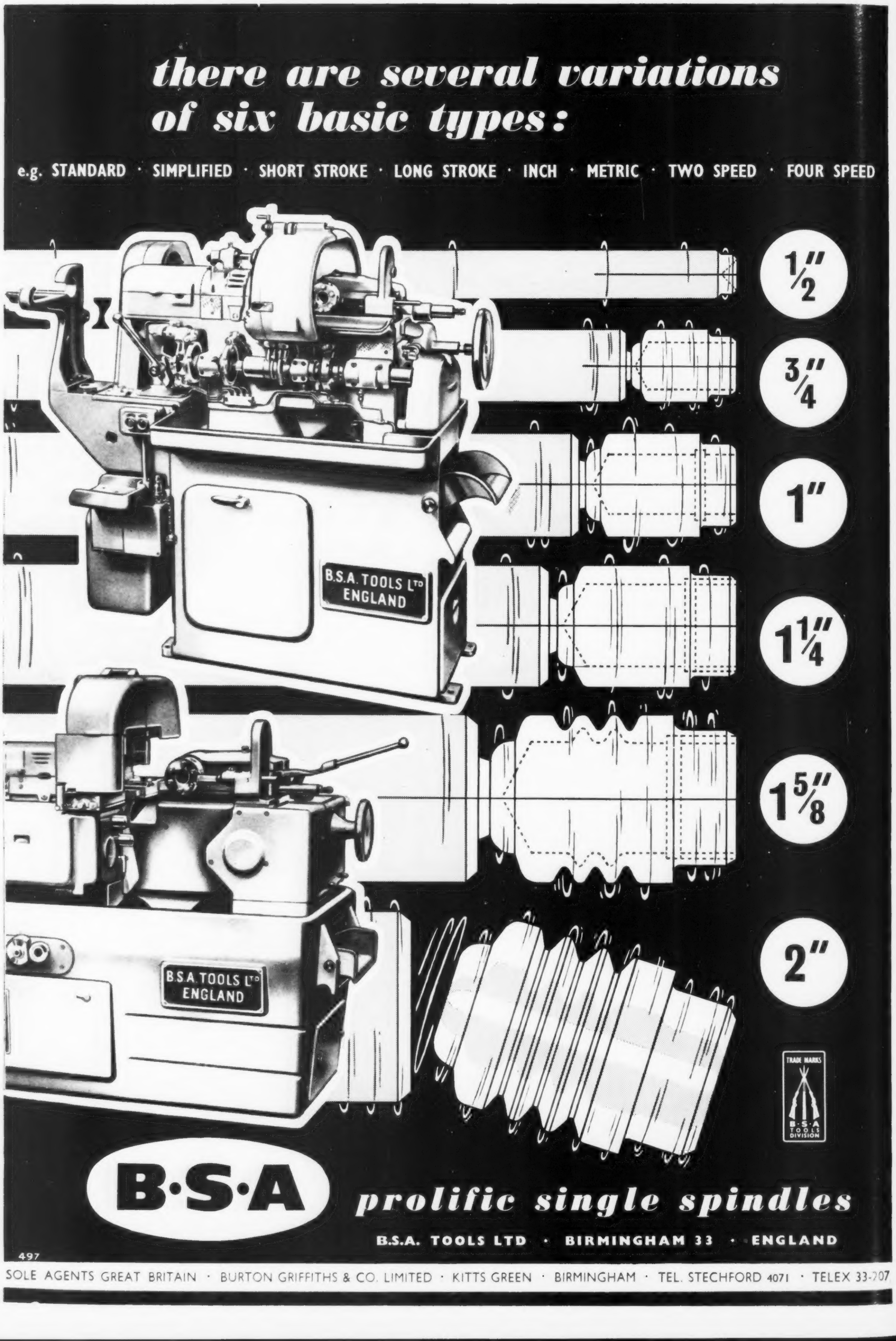
Available with 26", 30" or 40" cradles. Up to 0.200" stock may be removed. Tapered contours, in one direction, or both can be ground on a production basis.

DATA

Grinding 13 Contours on Camshafts for 6 cylinder engines, removing .010" stock, production is 12 Camshafts per hour, one man operating 4 machines.

LANDIS LUND **5" x 40" TYPE DH CAM GRINDER**

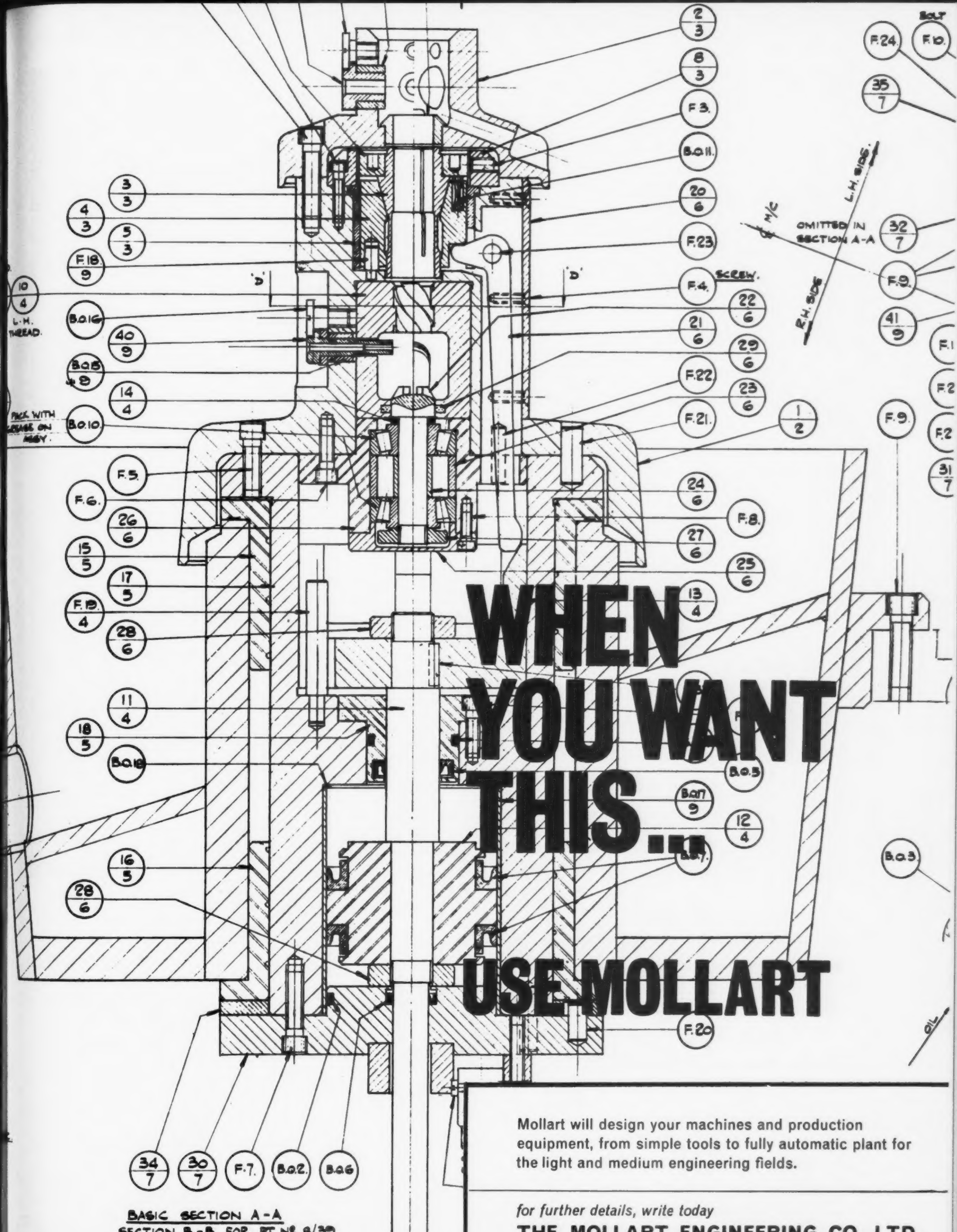
LANDIS LUND LIMITED - CROSSHILLS - KEIGHLEY - YORKSHIRE


there are several variations
of six basic types:
e.g. STANDARD · SIMPLIFIED · SHORT STROKE · LONG STROKE · INCH · METRIC · TWO SPEED · FOUR SPEED
1/2"
3/4"
1"
1 1/4"
1 5/8"
2"
B.S.A. TOOLS LTD ENGLAND
B.S.A. TOOLS LTD ENGLAND
TRADE MARKS
B·S·A TOOLS DIVISION
B·S·A
prolific single spindles
B.S.A. TOOLS LTD · BIRMINGHAM 33 · ENGLAND
497
SOLE AGENTS GREAT BRITAIN · BURTON GRIFFITHS & CO. LIMITED · KITTS GREEN · BIRMINGHAM · TEL. STECHFORD 4071 · TELEX 33-707

gineer

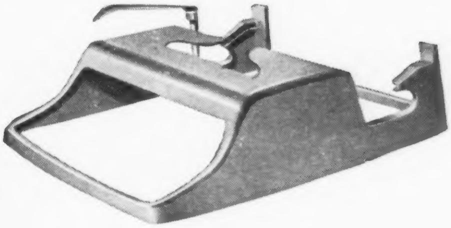
PEED

33-707


BASIC SECTION A-A
SECTION B-B FOR PT No. 8/39
OMITTED IN SECTION A-A
L.H. SIDE
R.H. SIDE
L.H. THREAD
PACK WITH GREASE ON ASSY.
SCREW.
BOLT
OIL

Take a letter

Miss Sims

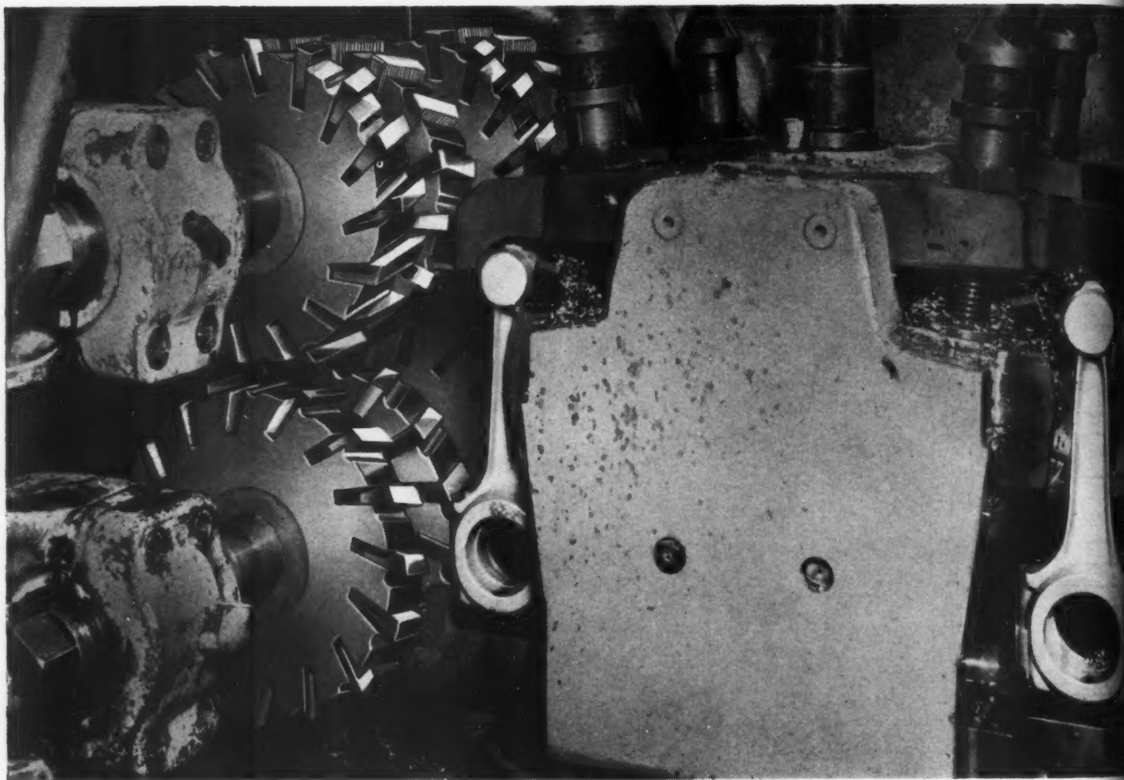


The perfect secretary, aren't you, Miss Sims. Brisk, efficient and businesslike. You know how to get the best out of your typewriter. Just as the typewriter manufacturer knows how to put the best *into* it—pressure die castings, for instance.
Pressure die castings offer manufacturers high quality components at remarkably low cost in a variety of pleasing finishes. And the massive scale of production that can be achieved helps everyone to enjoy a high standard of living.
Wolverhampton pressure die castings in zinc and aluminium point to progress in a big way.
Your enquiries would be welcomed.

THE WOLVERHAMPTON DIE CASTING COMPANY LIMITED

GRAISELEY HILL, WOLVERHAMPTON TELEPHONE: WOLVERHAMPTON 23831/7

At MORRIS it's...



MILLING

One of many operations at Morris Motors Ltd., Coventry, on which GALTONA serrated blade cutters are used, is the milling of connecting rods as shown above. Eight 9″ dia. half side cutters are used and the large and small end faces on two rods are milled simultaneously.

Our Tool Engineers will be happy to co-operate with you on your own production problems and we invite you to get in touch with us.

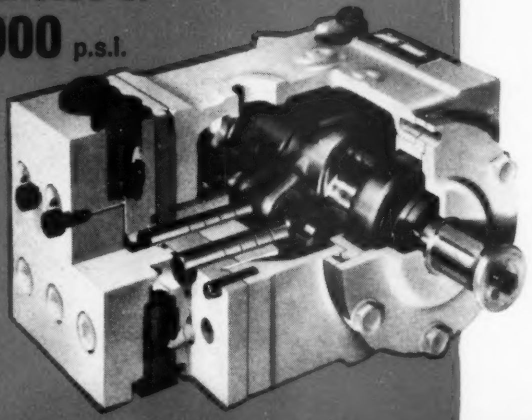
GALTON HOUSE, ELMFIELD AVENUE, TYBURN, BIRMINGHAM, 24
Telephone: Ashfield 1801, Telegrams "Cogs, Birmingham"

NORTHERN AREA OFFICE: Britannia House, Wellington Street, Leeds, I. Phone: Leeds 21212
LONDON AREA OFFICE: 240 Romford Road, Forest Gate, London, E.7. Phone: MARyland 7304-5
NORTHERN IRELAND: Garage and Engineering Supplies Ltd., 78 Great Victoria Street, Belfast
SCOTLAND: Stuart & Houston, 5 York Street, Glasgow, C.2

KEELAVITE
Hydraulics

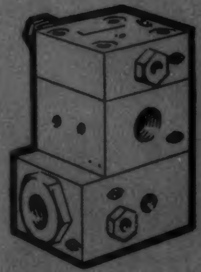
KEELAVITE GURY [KG]

CAPABLE OF PRESSURES IN EXCESS OF 7000 p.s.i.



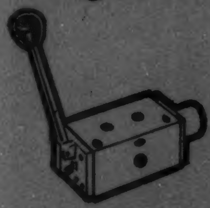
HYDRAULIC PISTON PUMPS

The new Keelavite/Gury fixed capacity piston pumps are capable of maximum pressures of as high as 5700 p.s.i. for continuous running or, in excess of 7000 p.s.i. for intermittent use.
Capacities range from 0.43 g.p.m. to 44 g.p.m. at 1500 r.p m. The design and construction of these units give exceptionally silent operation and extremely long life.



K.G. SERIES OF HIGH PRESSURE VALVES

Type BVDCR Bypass and Off loading Valve.



Type TN Directional Valve

Specification of a few of THE K.G. SERIES OF PISTON PUMPS

Type	Bore/ Stroke	Flow in g.p.m.		Cont. Service at 1500 r.p.m.		⅓rd Service at 1500 r.p.m.		1/10th Serv. at 1500 r.p.m.		Wt.
		1000 r.p.m.	1500 r.p.m.	max. pr. p.s.i.	Input H.P.	Max. pr. p.s.i.	Input H.P.	Max. pr. p.s.i.	Input H.P.	lb.
GVS		0.28	.43	5700	2	6500	2.5	7100	3	62
	12.12	0.8	1.21	6000		6750		7100		62
GV6	14.12	1.1	1.65	4600	6	5400	7.5	6000	8	62
	16.12	1.47	2.2	3600		4300		5000		62
	16.15	1.87	2.76	5700		6500		7100		86
	18.15	2.32	3.53	4600		5460		6000		86
GV15	20.15	2.97	4.4	3600	12	4390	15	5000	17	86
	20.20	3.97	5.83	3000		3600		4000		86

The above figures refer to the three smallest pumps in the KG range. Altogether there are nine sizes, and by varying the stroke/bore dimensions twenty-two different ratings are available. Double pump units are made up to fulfil specific requirements. Literature giving full particulars will be sent on request.

THE RECOGNISED AUTHORITY ON HYDRAULIC POWER TRANSMISSION

For full details write to

KEELAVITE
Hydraulics

KEELAVITE HYDRAULICS LTD
ALLESLEY · COVENTRY · TEL: MERIDEN 441

KEELAVITE COMPLETE HYDRAULICS
— a complete range of units
— thirty years of hydraulic experience
— and a service that means success

e

ion

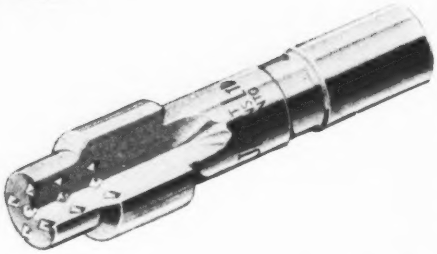
JKS

To secure efficiency

You know the tremendous importance to your work of the truing and dressing of your abrasive wheels. The choice of the right tool is vital.

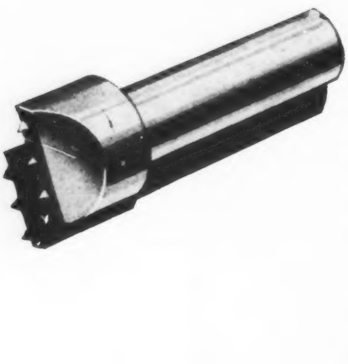
The selection of the correct diamond for the particular work that tool has to do is our responsibility. Our unqualified acceptance of the fact and our realisation of the responsibility account for the unquestionable success of JKS Diamond Abrasive Wheel Dressers.

Our knowledge of diamonds and their multifarious industrial applications, our experience in the development of such means of production, are an assurance that we can give you precisely the right tool to secure the efficiency of your wheels at the lowest possible dressing cost.



The standard range of JKS Abrasive Wheel Dressers is designed to meet the major needs of the diamond using industries with efficiency as well as technical and commercial success.

Industrial progress, however, is always making fresh applications of the diamond, which raises new diamond tool problems. The JKS Technical Advisory Service exists not only to solve such problems on a basis of economic production, but also to make its own individual contributions towards industrial diamond development. Our experts are precision engineers versed in every phase of diamond tool manufacturing practice, as well as in the practical application of the tools within the industries to which they are supplied.



These men work with a background of some 60 years of industrial diamond development. They know their job, from diamond mine to the diamond's latest industrial application. It is not too much to say that they are already working on the way diamonds will be applied tomorrow.

That is the kind of service at your disposal when you come to JKS for Abrasive Wheel Dressers. You obtain an expert consultative service as well as a singularly efficient and very comprehensive diamond tool manufacturing organisation which has established an enviable reputation for friendly, expert, practical co-operation.

The customer's working costs and interests come first with JKS.

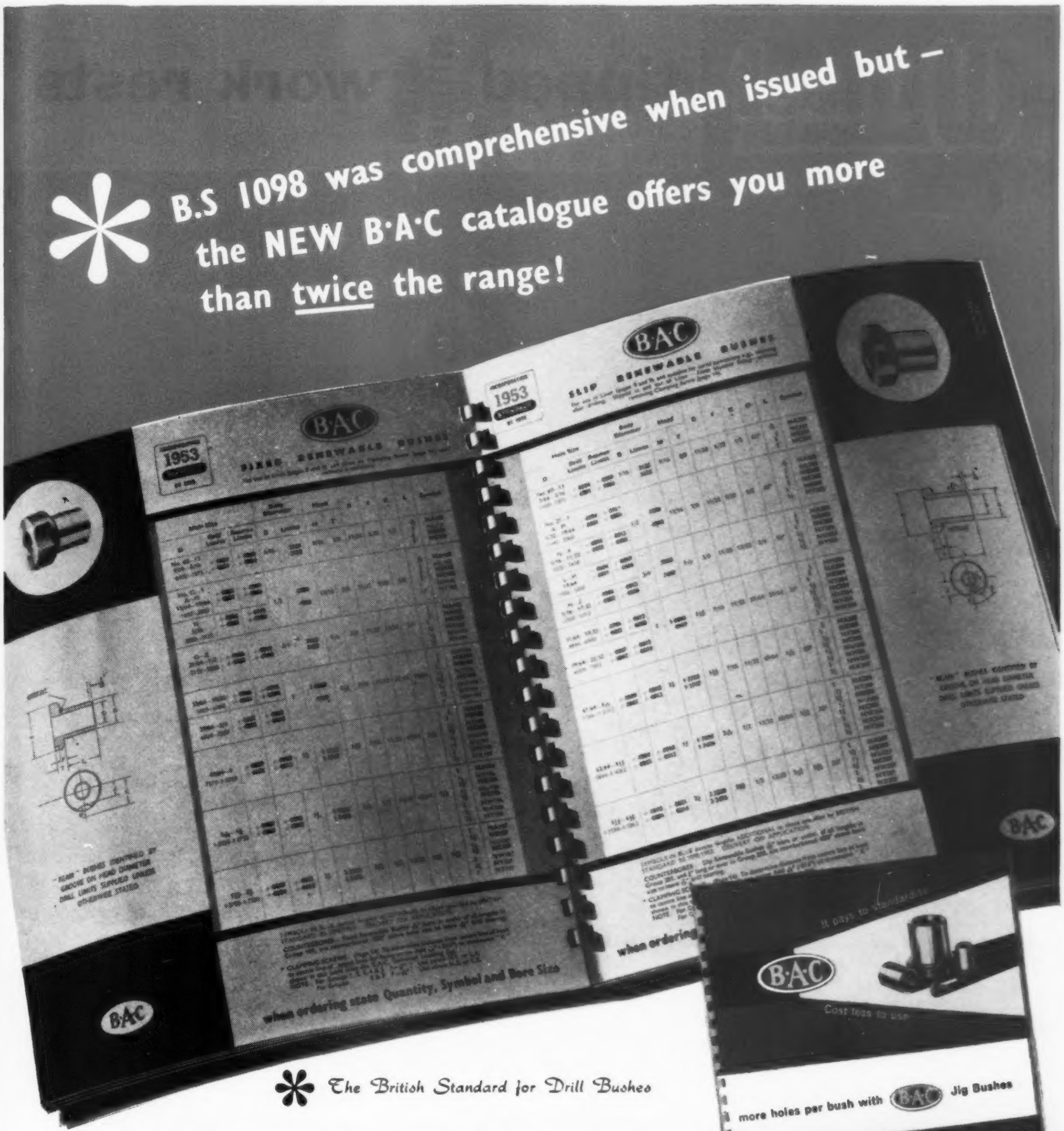
J. K. SMIT & SONS

DIAMOND TOOLS LTD

22-24 Ely Place, Holborn Circus, London, E.C.1. *Telephone: * Holborn 6451*

2 St. John St., Deansgate, MANCHESTER 14 Queens Rd., COVENTRY *Works*: Mochdre, Colwyn Bay, Denbighshire

Also at Murray Hill, New Jersey, U.S.A · CANADA · HOLLAND · FRANCE · AUSTRALIA



* *The British Standard for Drill Bushes*

This is the 10th edition of the B·A·C Catalogue. It contains even more information than before – for example, full data about the extra lengths now included in the B·A·C range as well as the new Universal Drilling Jig for lock screw location.

SEND FOR YOUR COPY TODAY

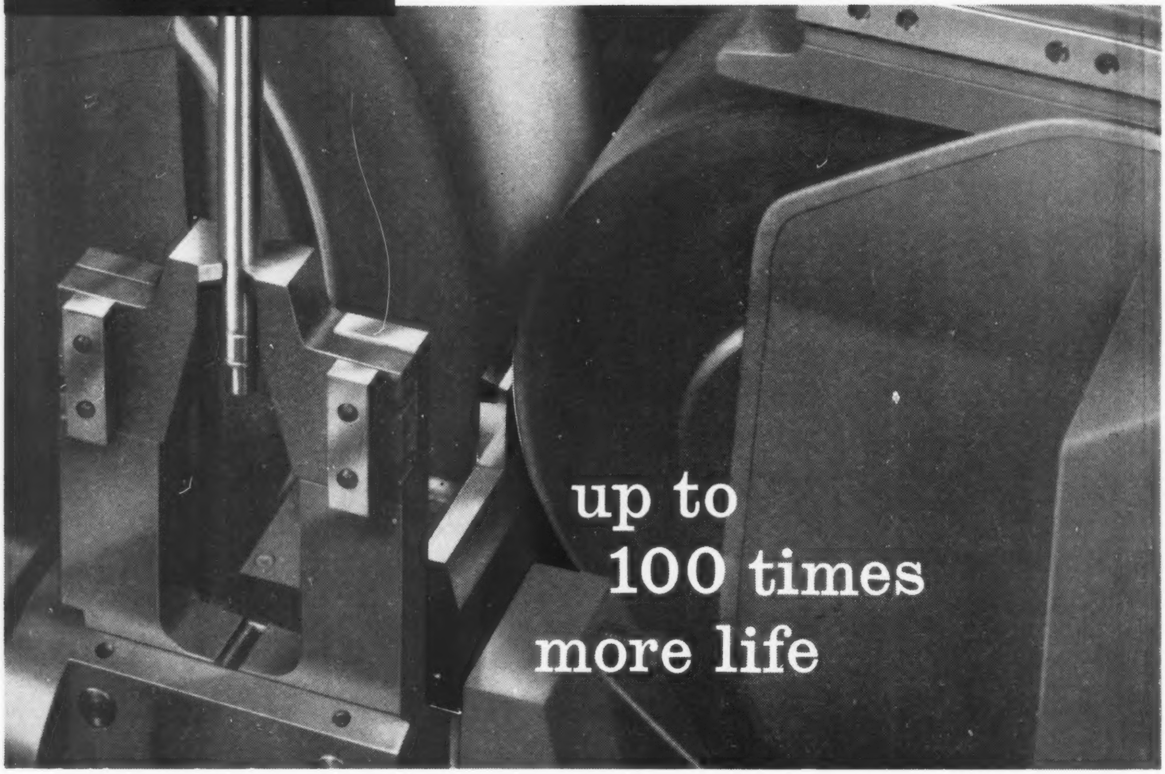
B·A·C

WORLD'S BEST DRILL BUSH

BRITISH AERO COMPONENTS LTD., MONTAGUE ROAD, WARWICK, ENGLAND.

Telephone: Warwick 320 Telex 31544 Telegrams: "Aeroparts"

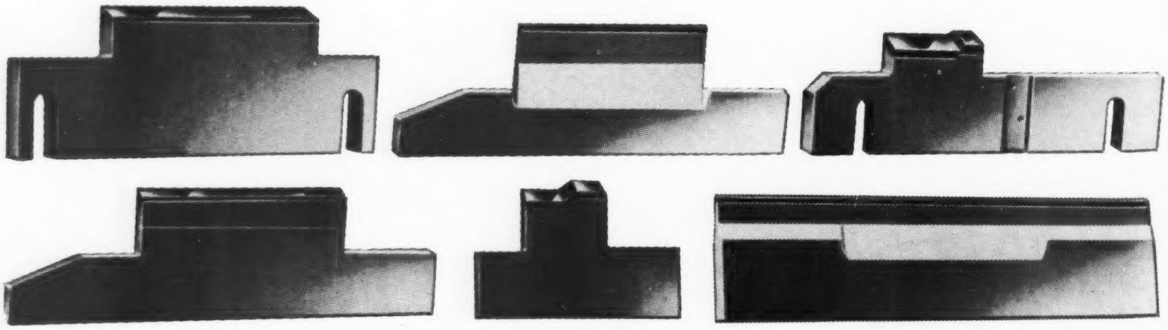
Wimet tipped CENTRELESS GRINDER work rests



ADVANTAGES

1. **The high wear-resistance of Wimet gives a life of up to 100 times that obtained from conventional steel blades.**
2. **Long life helps to assure the maintenance of high accuracy in the work produced.**

Standard sizes and styles for PLUNGE and THROUGH-FEED GRINDING available for all machine makes



587

WICKMAN LIMITED

WIMET DIVISION, TORRINGTON AVENUE, COVENTRY. Telephone: Coventry 66621

"Wimet" is the Registered Trade Mark of Hard Metal Tools Ltd., a Wickman associated company

The Production Engineer

THE JOURNAL OF THE INSTITUTION OF PRODUCTION ENGINEERS

VOL. 40 No. 12 DECEMBER 1961

THE ANNUAL DINNER, 1961

The Annual Dinner of The Institution of Production Engineers was held on 1st November, 1961, at the Dorchester Hotel, London, and was attended by more than 500 members and guests. The guest of honour was The Right Hon. Viscount Chandos, P.C., D.S.O., M.C., President of The Institute of Directors and Chairman of Associated Electrical Industries and of the Northern Ireland Development Council, who presented the Institution's Annual Awards during the evening.

The President of the Institution, Mr. Harold Burke, was in the chair.

IN proposing the toast of "The Guests", the President said:

It is with very great pleasure that I propose this evening the toast of "Our Guests". We are glad to welcome as visitors, prominent industrialists to contribute, we hope, to the thoughts we have before us. We are pleased to have with us, too, educationalists and scientists and this is particularly appropriate because this is a time when the Institution is thinking more and more of the question of education in relation to the work that lies ahead. We welcome the educational members of our Institution as men in that particular category and we welcome members of kindred institutions and extend to them the hand of friendship and co-operation; and we shall hope that we may see something of the problems before us on which we work together.

I am sorry it is not possible for us to welcome members of the Diplomatic Corps, as is our usual practice, representing as they do the States of the Commonwealth. I understand, however, there is another party in some other place—Buckingham Palace, in fact—but in welcoming our guests it may be a little difficult to mention any of them by name since perhaps I should be guilty of forgetting one or two of them. But I would like to say how pleased I am to see Miss Anne Shaw here this evening—a very distinguished member of the Institution who, as you know, is a world authority on time and motion study and a lady we greatly respect; and another lady member, Miss K. M. Cook, an industrialist in her own right.

Despite what I have said about not mentioning names of our distinguished guests, I should like to offer a special welcome to Captain Eyston, whom we are all delighted to see here this evening. I propose to say something on our guest of honour a little later.

Lord Chandos, guest of honour, is received by the President, Mr. Harold Burke.

This is the platform where once a year the Institution is privileged, through its President, to say something of the problems before the country, the Institution, the members and all of us. I would suggest we are living in troubled days and that that has an impact on our thinking to a very marked degree. What has been happening this week with regard to nuclear weapons has surely demonstrated the biggest breakdown in human relations in world history; and bringing that closer to ourselves and examining the problems, we begin to wonder where we fit into the task of establishing world peace. But we are probably just as much concerned today with the problems within our country, since that is something about which we can do something.

We are concerned with the economy of the nation and with industrial progress, and this is where the Institution has a right—nay, a duty—to say what they feel, to do what they feel they must and to see it gets done for the good of mankind, and perhaps of this country in particular at this stage. I am suggesting that this country is part of the pattern of the world as a whole, that industry is part of the pattern of this country and that we are the people concerned. We must, therefore, take time to ask ourselves just exactly where we fit in in this situation.

education for management

If we study the industrial problem we are all concerned with the fact that we feel that in Britain we are not making nearly enough progress in top management structures. You can hardly pick up a paper or magazine in these days without reading an article or press report on what some prominent industrialist has said on the problem of education for management. I believe we all accept the fact that the management of industry is a job for scientific application.

No longer can we say we can aspire to reach the top of the tree just by luck or by virtue of knowing the boss. It is a problem of being able to get into management and to do what we can for industry by hard work, by brains and by guts. If we examine the situation in industry we shall probably find where we are failing most.

progress is too slow

Our universities and colleges throughout the country are making a valiant effort to deal with the question of training for management but I must say I feel that progress is far too slow. In terms of percentages in this field we rank with a country like Yugoslavia; we are well behind countries like Russia, Germany and the United States of America; and until we can stimulate thought and action in our universities and colleges, through the Government, so as to have far larger numbers of candidates coming forward to be trained in top management, we cannot fold our hands and say our job is done.

I believe there is still much in the university field that can be done by the Government. I am hoping we shall be able to see the six new universities established with a Department in Production Engineering. The Institution has already communicated with them on this and we are hoping they can be persuaded to see the importance of it. But there are a large number of universities in this country with engineering facilities but without production engineering courses in their courses of study; and what we are trying to do is get them interested in this work. More than that, we are trying to insist they have a duty in that direction.

The Institution is taking a special interest in Birmingham University because that, at present, has the only occupied Chair in Production Engineering in this country, and in a very short time—a matter of weeks—I hope to be able to tell you of the detailed work that the Institution is planning in connection with Birmingham University.

giving a lead

We feel we have here an opportunity to give some practical assistance, to give a lead, on how we think that can be done. But this is in no way intended to detract from the work done by the Colleges of Advanced Technology. On the contrary, I believe it will be complementary to what the universities are going to do. In fact, I have a great admiration for the advanced colleges and the work they are doing under trying conditions.

It is significant that the real control has been transferred from the local authorities to the Government. I hope that that is a move for the better, because without better facilities and more money and staff they will not be able to cope with all the students who are trying to get these courses in higher management techniques.

I hope it will not be long before we see degree courses in Production Engineering. This is in no way intended to criticise the Dip.Tech. diploma on which

splendid work is being done throughout the country. It may be complementary to it, but there is a great psychological as well as practical value in being able to offer students a degree course in Production Engineering.

Where do we stand in relation to Her Majesty's Government? I feel that at the moment the Government are failing to realise, in spite of all the talk, that productivity is the keynote of the economy of the nation—because if they did realise that they would be doing more about it. Several months have been spent trying to form a Planning Committee and to construct its terms of reference. This is a matter of the greatest urgency. If we have to wait months to settle the terms of reference, how long must we wait before we get results?—and that is what we want. We have to do something right now.

A Minister of Production

I believe the answer is for the Government to appoint a Minister of Production and I mean (speaking with respect) a top-ranking industrialist, at Cabinet level—not a politician. (*Applause.*) I believe this is essentially a job for an industrialist with the necessary experience. I think the time has come when we must stop using words for the sake of trying to do something we do not really mean and we must initiate action which industrialists and trades unions understand, and on which they will do something because they respect a decision as being right and fair.

If it is felt right for British Railways to have one who is considered to be a very high-ranking administrative industrialist in charge of them, how much more important it is that we have the best brains we can find to advise and guide the industries of this country!

I feel that to have anything less is to pay lip-service to the question of productivity, and that must be improved before wages can be improved. Let us be realistic. We are not going to hold the wage "pause" down indefinitely. We are going to see, I hope, that wages are related to productive effort: but let us be sensible about it. At present all we have is talk and no way in which something can be done. I suggest that if the Government care to appoint an important Minister of this order, it will go a long way towards establishing confidence in what industry is trying to do. (*Applause.*)

time for fresh thinking

I have referred briefly to human relations on the subject of the nuclear bomb tests and I suggest that industrially speaking, human relations in this country have reached a very low ebb and it is time for fresh thinking. I am not at all sure that the present machinery should not be re-examined with a view to seeing whether the terms of reference in dealing with such things ought not to be reconstructed.

I am not attempting at this stage to analyse the situation or apportion any blame. But if we take the trouble to look at the causes of some of the disputes going on in this country now, we are shocked to feel that that kind of thing should be happening in 1961 and there is very little that we appear to be doing about it. We are so apt—are we not?—to say it is someone else's problem, that we have this and that to attend to.

The most important problem we have to consider is whether it is our responsibility and if it is what we are doing about it. I am not suggesting, of course, that the members of The Institution of Production Engineers are the sort of people who can put the country to rights. I am not suggesting we have the answer to all these problems. I am suggesting, however, that engineers as a whole can make a major contribution if they will get together and consult on ways and means of doing the things we are always talking about. I suggest if we care to make a start on the problem in our factories we could call together our design engineers, development engineers, sales managers, cost accountants and production engineers to discuss these questions from all angles. Why do we choose to remain aloof from each other when we are talking about national economy?

I am delighted that we have with us tonight members of kindred institutions, because I am hoping that in 1962 we shall see a growing awareness of the need for co-operation between senior institutions on the matter of productivity, which is not just a question of development and design but a question of complete co-ordination, and recognition of the fact that the production engineer is an important member of the team. He should not be regarded as a small tooth in a large cog, or a poor relation of the administrative machine.

importance of co-operation

The science of the technique of manufacture is one of the most important things with which we

The President greets The Institution's senior lady member, Miss Anne Shaw

have to deal today. How do we make something better than anyone else, at a lower price than anyone else can make it? It is, of course, by application of continuous study and brains and through complete co-operation between the designer and the development engineer; and I feel that if we, as an Institution, can recognise that we are not in a watertight compartment but are part of the national economy, that we are the people in the country who are concerned with how we can improve things here, we can extend a hand to all our brother members of other institutions and say, "Can we get together? May we help on this terribly important task?"

Speaking now just to the members of our own Institution I would say: how often we talk about acceptance of responsibility! Just precisely what does it mean? What does it mean to you? What does it mean to those who listen to a man giving a lecture, or working at their daily job, if we are not all prepared to accept, in the widest sense, responsibility for something other than the job for which we are paid? I believe that that is the important thing that we want to get across, this wide dissemination of information, this spreading of the gospel, this willingness to learn and to accept increased responsibility. All that is something which must become fundamental and yet something we are too often so anxious to avoid. Therefore, I say to members: Here is where you fit into the pattern. Through sectional and regional meetings, in co-operation, in stimulation and in methods by which you can encourage and teach younger members to take over the responsibilities that lie in your particular field of industry.

There are, in this Institution, 13,000 qualified production engineers, all of whom make, every day, decisions affecting our national economy. That is a very large build-up of scientific discovery and determination as far as final results are concerned. Thirteen thousand people can make positive decisions in the right direction, all of which will help their companies and themselves and, of course, the country.

I want to stress the point that I so often try to make—that this country is *us*! It is not just something remote, round a corner. And if we start with ourselves, examine what we are doing and determine to do something better about it, then I feel sure we shall find the job has been worth doing. If we accept the task with enthusiasm in an endeavour to make our personal contribution of help in this, it will grow and we will go away saying: "There is a job for me".

I have to couple with this toast the name of our distinguished guest of honour, Lord Chandos, so well known to you that I feel anything I might say of him must be completely superfluous. He is, of course, Chairman of that great group of companies, Associated Electrical Industries, Director of I.C.I., President of the Institute of Directors since 1954, Chairman of the Northern Ireland Development Council since 1955 and President of Manchester College of Science and Technology since 1956.

He was Member of Parliament for Aldershot from 1940 to 1954 and President of the Board of Trade, 1940 to 1941. He was Minister of Production and a Member of the War Cabinet from 1942 to 1945 and Secretary of State for the Colonies from 1951 to 1954. Here may I interpose that in 1942 the Institution drew up a Memorandum to be sent to the Government on what they considered ways and means which should be adopted to increase productivity. That was 19 years ago and we are still talking about it.

Many other things have happened since then, of course, but I think it is significant that that Memorandum should have been sent to the President of the Board of Trade of that time, who was the Right Hon. Oliver Lyttelton. I doubt if he remembers that, but he remembers many other things and I would like to say, on your behalf, how delighted we are that such a distinguished statesman and industrialist should find the time, in the extraordinarily busy programme he has, to come and spend an evening with us and find time to think about what he is going to say in reply to this toast.

We look forward with great eagerness to listening to what he has to say to us, and I now ask members to rise and drink to our guests, coupled with the name of our principal guest, the Right Hon. Viscount Chandos. (*Applause.*)

REPLY BY LORD CHANDOS

THE Right Hon. Viscount Chandos, P.C., D.S.O., M.C., in response said:

I am truly honoured that you have entrusted me with this task this evening, all the more so because the Chairman of your Council is the Director of Manufacture at A.E.I., Manchester.

The President touched, in passing, on the breakdown of human relations which has been caused by the explosion of the bomb and other things. I have an uncomfortable habit of asking the eminent scientists who sometimes work for my company: "To which particular school do you belong?" I say, "My dear Professor, it would be a great help to know if you belong to that group of scientists who think there will be no human life on this planet within 25 years, or to that group who say there will be so many that it will be impossible to feed them."

As an industrialist I have to try to do my best to run the policy of the company between the horns of that painful dilemma. I will devote no time to discussing the position of the production engineer in our society because it is quite obvious that his must be one of the principal roles in leading the country,

both towards justifying Mr. Butler by doubling the standard of life in the next 25 years, or going still further to ever greater expansion and prosperity.

In our country it is not often recognised how much productivity is a function of capital and of management. Of course, we must admit that without a loyal body of workpeople who are working under happy and cheerful conditions, neither capital expenditure nor good management will achieve much. But advances of productivity depend on capital expenditure and skilful management. I think this is an important point which is often missed, because the tendency in British industry has been for wages to absorb nearly all the decrease in costs brought about by massive capital expenditure and skilful management.

It is, of course, quite unnecessary to underline the point to such an instructed audience as this, but an illustration might serve. If the use of computers enables us to control stocks and work in progress and the flow of materials through the shop floor more effectively than by man-made calculations, then we can look for increased productivity from the same labour force and the same square footage of factory space. But that increase in productivity owes practically nothing to labour as normally defined, and almost everything to the machine, the computer; and it must not be claimed that the whole of the benefits of that increased productivity should go to labour.

reward for wage-earners

I believe every increase in productivity, even if entirely due to the machine, should bring some reward to the wage-earners in industry. Some years ago I suggested we should have a wage agreement by which the wages of the workers would rise by 2½% per annum for three or five years; and I said such a scheme would not be inflationary because productivity would certainly rise by some 3½%. The reaction of some leaders in the trade union movement was interesting. They asked, "Why the gap? If productivity is going up by 3½% why should not wages go up by 3½%?" Of course, that is absurd because productivity is largely a function of management and capital expenditure. Imagine getting increased productivity by exhorting people to work harder! If I were to do that I should be greeted by rude noises. It was all right for Henry the Fifth, but it does not work today.

Even among the awards to be given this evening there is one for a Paper on "The Maintaining of Production Potential with Shorter Working Hours by means of Advanced Management and Production Techniques". I think that is an admirable title for a Paper, although I do not know why the word "potential" has been put in there.

Another part of productivity, apart from mechanisation and happy labour relations, lies in the field of management and I agree there is a large gap in our educational system requiring our earnest attention. This other aspect is the subject of statistics which are more than usually boring, relating to the numbers passing through the universities or schools of Russia or the United States—which are quite beside the point. They prove nothing.

The first gap in our system is that a boy has now to elect for humanities or for science and engineering at far too early an age. We must secure that young people are given at least some grounding in matters of science so that if, later, looking at the world in which he is to live with more mature eyes, he wishes to change from the humanities to a technical education, he already possesses at least the fundamentals on which to build a career in engineering or science. Of course, the humanities tend to be more attractively taught than science. We in industry draw so much of the best brains from engineering and science into production, day by day, that the teaching profession is a little thin in that field. That is the first thing.

training for management

Secondly, as your President has mentioned, training for management in this country requires expansion and improvement. A graduate engineer has undergone a long and expensive training. It is difficult to get into a university and he has had to spend three years getting a B.Sc. degree and then two years in a shop. If he then goes into a branch of engineering and makes a success of his career then at 30 he finds himself in charge, perhaps as superintendent of a works employing 1,000 people; and suddenly the problems coming on his desk have nothing to do with engineering but concern many other things, at least for part of his day.

He has been highly trained in engineering but when it comes to dealing with a trade union or a tea-break dispute, nothing in his early training guides him. He has been taught that engineering is a matter of measurement; but he also finds he must ask himself whether to go on producing for stock, whether or not the markets are contracting, or if the Government policy is likely to change, and many other such questions. He must ask himself whether with 7½% money he is right in manufacturing for stock.

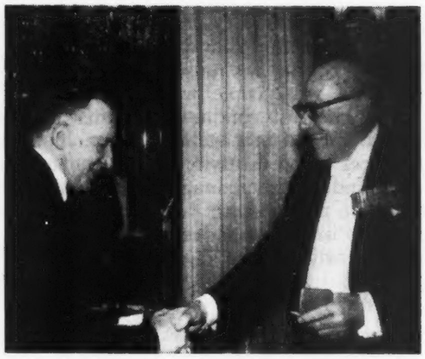
Engineers are not trained in all these matters and we want, in our general educational system, a period in ordinary business training and management, enabling a highly-skilled specialist to bring general knowledge to bear on the general problems which will face him. Therefore I agree that we have to try to expand training in higher business management.

plain speaking required

Going back to the Institution, I am impressed by the fact mentioned by your President, that you can make a decisive contribution, and while you will succeed in persuading some people, I think engineers are not always particularly skilled in making their ideas appeal to other men. It might, therefore, be worth considering using the Queen's English in a way other people will understand, rather than

PRESENTATION OF ANNUAL AWARDS

Mr. K. J. Hume was awarded the Institution Medal for the best Paper presented by a Member. This was the second occasion on which Mr. Hume has gained this award



Mr. H. Grisbrook received the J. D. Scaife Medal for the best Paper published in "The Production Engineer"

Mr. E. P. Ward was awarded the Institution Medal for the best Paper presented to the Institution by a non-member

The 1960 Schofield Scholar, Mr. J. S. Hawkins, is congratulated by Lord Chandos

Mr. P. J. Varley won The Lord Austin Prize for the best essay submitted by a Graduate of the Institution, for the second year in succession

jargon which appears to have more to conceal than to disclose in the process.

We wish to secure that the industrial army gets the right orders from the top, that those orders are properly communicated to the troops — and The Institute of Directors is to have courses in communication. It is no good living in a Trappist atmosphere where what you think cannot be conveyed to others. It is important to make a speech which is understandable and therefore we want to achieve this proper communication and to see that all march as far as possible in step, conscious of the fact that they are advancing upon a common plan, towards a common objective which will reward both capital and labour, the one for its risk and the other for its work, in a manner that will lead to the prosperity of the nation as a whole. (*Applause.*)

Mr. R. H. Turner, M.A. (Chairman of the Council), in a brief acknowledgement, said :

It is my privilege at this stage of the proceedings to render thanks to those who have been responsible for the success of this, our Annual Dinner. This is something in which I take particular pleasure tonight, because although it might be said that the number of these occasions tends to double every ten years—rather like the production of power or anything else—nevertheless, to every institution or association concerned, each individual occasion is of its own prime importance.

The importance of this function tonight is that we have Lord Chandos as our principal guest. (*Applause.*) To me this is a particular pleasure in that at long last we have persuaded him to visit us; and I am delighted he has seen fit to do so during my term of office. We have been delighted to hear one of his sparkling speeches in which we can all take very great pleasure.

That speech was refreshingly down-to-earth, as befits a past Minister of Production. Lord Chandos knows only too well the problems facing production engineers and production engineering generally. As leader of a great industrial empire and as one who participates to no small extent in the chemical industry and the financial world, he is a man to whom we can listen thankfully, and whose words we can accept as guidance to our future. We are most grateful to him for finding time to grace our function. I thank him also for undertaking the extremely arduous task of presenting the prizes, which I noticed he did with his customary skill and distinction.

I am sure you would wish me to refer to our worthy President. (*Applause.*) He has made what is customarily known as a "fighting speech"—a speech which was not merely a collection of words thought up for this particular occasion but a speech which, I know, came from his heart. Further than this, I would say Harold Burke is not primarily a man of words but a man of action; and I think we can look forward, in our Institution, to real progress as a result of the action now being taken by our President. On behalf of the Council and members I would like to express to him our appreciation for the lead he is taking in this respect. We thank you most sincerely, Mr. President, particularly as you have succeeded in office a man whose name I must mention, Mr. Ronald Pryor (*Applause*) who set a wonderful standard in our Institution and one which will not soon be forgotten. Mr. Burke is following in his tradition and we are indeed grateful to him for being able to spare time (which he does unstintingly) in the interests of our great Institution. Thank you, Mr. President! (*Applause.*)

It would be unbecoming if I were not to mention those who have been responsible for the arrangements tonight, and I know this is customary; but nevertheless it is important that we should refer to the Headquarters Staff of the Institution, led by our very worthy Secretary, Mr. Woodford. (*Applause.*) As you may suspect, a great deal goes on behind the scenes in organising a dinner of this magnitude and I am sure you would agree that Mr. Woodford and his staff have done everything possible to ensure our comfort and entertainment this evening.

To all our members I would say 'thank you' for coming along tonight. I am sure you have found it worthwhile and I thank you also for bringing with you the many guests who have graced our function tonight. They are most important to us at this particular juncture in the affairs of the Institution. We are confident that what you have heard tonight will do nothing but good towards the furtherance of production engineering in this country. We are grateful to you for coming and supporting this function. We look forward to seeing you again next year. I thank you for listening to me patiently and responding so well to the acknowledgements. (*Applause.*)

THE HUMAN ELEMENT AND PRODUCTIVITY

by F. W. LIMB, C.G.I.A., M.I.Prod.E.

Works Director,
Ericsson's Telephones, Ltd.

Mr. Limb, Works Director of Ericsson's Telephones, Ltd., has been with the Company for over 35 years, during which time he has held the appointments of Chief Engineer, Joint Factory Manager, and Factory Manager.

He received his early training in communications in the Post Office Engineering Department.

Mr. Limb presented this Paper to a Conference organised by the North Midlands Region of The Institution of Production Engineers in April, 1961.

WHAT we are going to discuss are the human needs of our industrial society in meeting the needs of the community as a whole. The problem is world-wide in scope but it will be sufficient for our purpose if our main argument centres around our own industrial society, with such references to other countries as will help to illustrate the pattern here.

What distinguishes the subject matter of this address is the ratio of what has been and is being said and written and the effective results. To develop this Paper I made some excursions into the literature of the subject and have been somewhat surprised at the amount available. It would seem that every possible angle has been examined and written up, particularly in the U.S.A., so that lack of information sources could never be advanced as a reason for the apparent lack of results. The fact that so little practical application appears to have resulted from this available welter of words, and with the need so clearly demonstrated so many times, is indicative of the depth of the problem and it is a compliment to The Institution of Production Engineers that on many occasions they have provided a platform for discussion on this and related matters.

the economic background

Adam Smith, the noted economist (1723-1790), in a comment about the balance of economic power existing in the eighteenth century, said, "We have no Acts of Parliament against combining to lower the price of work, but many against combining to raise it".

This meant that in the normal course of events the income of the working masses would be pressed down and down, but there was a lower limit. "A man must always live by his work, and his wages must at least be sufficient to maintain him. They must even upon most occasions be somewhat more; otherwise it would be impossible for him to bring up a family, and the race of such workmen could not last beyond the first generation."

J. K. Galbraith, in his book "The Affluent Society", comments that this was the beginning of perhaps the most influential and certainly the most despairing dictum in the history of social comment, the notion that the income of the masses of the people—all who in one way or another worked for a living, whether in industry or agriculture—could not for very long rise far above the minimum level necessary for the survival of the race. It is "the immortal iron law which, as stiffened by Ricardo and refashioned by Marx, became the chief weapon in the eventual ideological assault on capitalism".

Smith was followed by David Ricardo (1772-1823) and Thomas Robert Malthus (1766-1834) and with them the notion of massive privation and great inequality became a basic premise. Mass poverty was considered inevitable, however much the total national wealth rose. Ricardo summarised the "iron law of wages" in the comment: "Labour, like all other things which are purchased and sold, and which may be increased or diminished in quantity, has its natural and its market price. The natural price of labour is that price which is necessary to enable the labourers, one with another, to subsist and perpetuate their race, without either increases or diminution."

The conditions under which these basic ideas developed should be understood. The mass of the people always from time immemorial had been poor and indeed generally upon a level of near starvation and both Ricardo and Malthus were looking into an improving future, certainly upon the basis of gross inequality, but this was claimed as naturally developing from the competitive nature of things. Progress would enhance the wealth of those who were rich, but not of the masses.

It was not claimed as any virtue that the inequality existed, that the rich became very rich, but it was claimed that this was the order of things and that if this was altered in any way the system would suffer and a greater evil follow, namely, that the poor would get poorer and become so poor as to be unable to exist. To be able to keep the poor just above subsistence level was worth some inequality of income, gross though this might be.

The basis of employment before the industrial revolution was that of master and serf or slave. The slave was a chattel of the master while the serf was somewhat better and had some established rights. As individual skills and crafts were found to be necessary, some artisans were able to purchase or otherwise establish their independence and to sell their products for reward. This period is generally described as the "agricultural period"; the predominant unit of production was the manor and the principal products were agricultural.

With the passing years both increased independence and increased specialisation were achieved by the artisans and with strengthening economic positions, they began to form craft guilds — this as early as the thirteenth and fourteenth centuries.

Within the craft guilds there were master craftsmen, journeymen and apprentices, each clearly defined; they usually all worked together in the master craftsman's home. Each member of the guild, if he were not already a master craftsman, might become one; apprentices were embryonic journeymen and master-craftsmen.

The guild system gradually disappeared with the advent of the industrial revolution, which brought with it expanding markets and improved transportation, increasing use of machine tools and the need for greater capital to set up in business. Journeymen, finding it increasingly difficult, if not impossible, to become master craftsmen, formed separate associations called Yeomanry Guilds and this was the start of separate associations formed to bargain as groups with employers. These Yeomanry Guilds were the ancestors of modern labour organisations.

The important thing to notice here is that the associations of all artisans in one group—the master craftsman who was the employer, together with the journeyman and the apprentice—recognised their mutual interests and the Guild gave status to both the journeyman and apprentice, in that the way up to master craftsman was inherent in the design and objects of the group; all who were employed in this way were in harmony. When the journeymen felt compelled to join a group separately from the master craftsmen, the identity of interest became lost and industry began to split into two groups, the employer and the worker; disharmony appeared with many opposing interests.

The factory system developed later, bringing to many revolutionary changes in the management of manpower and producing the industrial capitalist or factory owner; the worker faced the likelihood of retaining employee status throughout life, the artisan as a craftsman largely disappeared and work was generally simplified to a level of unskilled or semi-skilled operations.

the advent of mass production

Peter Drucker, in his book "The New Society", published in 1951, says: "The true revolutionary principle is the idea of mass production. Nothing ever before recorded in the history of man equals, in speed, universality and impact, the transformation this principle has wrought in the foundation of society in the forty short years since Henry Ford turned out the first 'Model T'."

A great point is made by Drucker of the separation of the worker from the product in a mass-producing system; the product is a collective product which is turned out by the plant, by the organisation, and separated from the plant the worker is nothing because he can produce nothing. This is an entirely

different world from that of the early traditional agricultural society where the vast majority, with little more than what they were born with or what they could make themselves, could and did produce for themselves. This new order of things makes the worker so dependent upon the means of production that the status and prestige system of the earlier society is shattered; it also makes the threat of unemployment unbearable and this not only for economic, but also for status reasons. The loss of self-respect and initiative arising from long-term unemployment is too well known to require comment here, except to say that these psychological factors are more important than the economic factors resulting from the loss of pay suffered by the unemployed.

The advent of mass production or industrialisation generally tends to destroy family cohesion and interdependence. Instead of the family working as a unit, the individual members are separately employed and even if they are in the same place of employment, they are no longer working as a family.

To a large degree the family has become a luxury; children are no longer an economic asset, but an economic liability and as a consequence the birth rate has declined with increasing industrialisation. Disturbances consequently arise in society which are reflected in the neuroses and complexities of modern living.

Non-Western societies, when industrialised and where the industrial growth is naturally so much more rapid, are profoundly disrupted by the impact upon their traditional way of life and in particular the impact upon their family life. The resulting social unrest is thus widespread and is becoming more so as industrialisation inevitably proceeds.

The worker generally is thus subject to strains and stresses never known in a traditional agricultural and craftsman society, and this basic disturbance naturally does little to help additional social problems arising from the individual employment in a particular organisation.

the experimental approach

Out of all the many experiments conducted in industry which have illustrated the profound importance of a study of human reactions to industrial employment, two might be mentioned.

the Hawthorne experiments

These experiments are so called because they were conducted at the Hawthorne plant of the Western Electric Corporation of Chicago, a company concerned with the production of communication equipment.

The company was then (1924) a most progressive company with first-class social amenities available to all their employees; they were conducting experiments in the relationship of illumination to output. To determine the information they needed they varied the illumination serving a group of employees under test and in the same shop kept a control group unchanged. The output of the group with improved illumination went up but, to the astonishment of the investigators, so did the output of the group which still had precisely the same conditions as before; obviously more was involved than a simple change of illumination.

From this start a series of experiments was undertaken under the guidance of George Elton Mayo, Professor of Industrial Research at Harvard, which lasted a number of years (mainly 1924-1927) and about which a considerable amount has been written. The more important aspects were determined from an examination over a long period of six girls doing an assembly job, who were separated from other groups for this purpose, and another examination of a group of men doing a series of wire connecting operations.

The attention given to this small group of girls resulted in marked increases in output under varying working conditions, all of which were most carefully documented. By asking their co-operation the investigators made the girls feel important; they were no longer separate cogs in a machine, but were a congenial group trying to help the Company in a problem. They had found stability, a place where they belonged, a clear need for their services and they worked better than they had ever done before.

This demonstrated sharply that a social function was being performed by the group as well as the production of goods, and that the group should be studied as a group rather than as isolated individuals within the group.

The group of men was studied to learn their personal reactions each to the other and the effect of this upon output. Again, some unforeseen results were obtained and knowledge was gained of the decisive control which was exercised by the unwritten laws of the group to control output around a point which it was judged (and very nicely judged) would give the least trouble to the group, both in terms of actual physical effort, and in terms of the least interference from management. The cash interest clearly had less influence than the gang interest, since it was invariably the case that the unofficial codes laid down by the group restrained output below what could have been relatively easily achieved.

It was apparent that the group developed its own natural leaders and had its own social structure and code of behaviour, which was generally in conflict with management whose intention naturally was to get maximum output. The problem here quite clearly is to get such groups, such teams, to work with and not against the management and to do this a really thorough understanding of group motivation is obviously essential. It should be appreciated, of course, that wherever group effort of any kind is required, such "unofficial" groups as described will arise.

the General Motors experiment

This took the form of General Motors asking their employees to write on the theme "My job and why I like it", and it was claimed for this method that it left the employee with a greater degree of freedom

of expression than interview techniques and attitude surveys then prevailing (1947). It was claimed that there was less direction of employee thoughts in the method and while the employee was asked to comment only upon what he liked about the Company, what he did not like was also clearly shown in the negative sense, by what he did *not* say. Supervisory and management grades were excluded from the contest. General Motors had four major objectives in promoting the contest and these were:

1. to encourage more constructive attitudes in the minds of employees by directing their attention to the positive aspects of their jobs;
2. to place in the hands of employees certain educational bulletins that would indicate some of the benefits derived from employment with General Motors;
3. to collect material for the enlightenment and education of supervisory and management groups;
4. to obtain a body of data for the analysis of employee attitudes.

The method proposed would clearly give good results if a good response was forthcoming and great efforts with competitions and a large array of valuable prizes, valued at 150,000 dollars, did eventually produce a response from nearly 175,000 employees. The total number of employees covered was 297,000 and thus a response was obtained from 58.8% of the total employees. This represents a most valuable contribution to knowledge of industrial relations, and more will certainly be heard from the detailed analysis of results than has as yet been published. The analysis itself was a most formidable task and eventually the subjects discussed in the letters were reduced to 58 themes and the frequency of repetition tabulated.

The findings have been similar to other employee-attitude surveys and confirm the results of experimental studies in showing that what influences employees is far from being solely, or even primarily, a function of basic wages or of wage incentives. These large scale attitude surveys plainly show the necessity of giving attention to a large variety of needs and wants to get the best levels of satisfaction and morale in industry.

The five most important factors were shown to be:

1. wages;
2. security;
3. supervision;
4. opportunity for advancement;
5. training facilities.

the industrial situation

It is tiresome, perhaps, to repeat that we have a national need for the maximum productive effort from every person gainfully employed. Tiresome or not, every advantage should be taken in an address of this kind to stress this national need. It is well known, but should continually be repeated, that our economy is precariously balanced and that if we do not achieve significant improvements nationally in productivity each year, our standard of living must fall. It is difficult to see how such a fall, once seriously begun, could be arrested before disastrous effects upon our economy resulted.

There is no doubt that we are not achieving the development in productivity which is necessary, and certainly not that which is possible, and most of us I think would suppose that we are not achieving the possible by a wide margin. The reasons could be grouped broadly under three headings:

a. *The national economic policy*
b. *The equipment to do the job*
c. *The man-power effort behind the job.*

The national economic policy is not within my competence to discuss. The equipment to do the job is lacking, and in many cases seriously lacking, and too many of us are working with equipment that is technically obsolete. I do not mean by that that our equipment in Britain is old, but I do mean that advances in technology have quite outstripped normal plant replacement patterns and we seem unable to make available the finances to maintain real technical efficiency, to replace perfectly working plant by better. We could do worse than follow examples from the U.S.A., where the mental approach is more receptive to innovation than ours.

The most serious lack is, of course, in the man-power effort. This is what we are discussing in this present Paper and certainly where our principal efforts must lie. There are a large number of factors involved and argument could arise on what are the principal ones.

I believe they are:

the general nature of industrial occupation;
the trade union position;
general industrial developments;
personnel problems in the plant.

general nature of industrial occupation

The bulk of employment in our industrial society is semi-skilled or unskilled and the nature of industrial occupation is thus that of a semi-skilled or unskilled operative; a great deal of industrial disquiet arises from a basic feeling of insecurity thus engendered. The skilled man is always in demand and so far as one can see, always will be. The semi-skilled man knows that he can be replaced by somebody having had a relatively short training and he is unable generally to feel that personal pride in skill nor achieve the group cohesiveness which belongs to the skilled man and his groups. All employees, skilled or unskilled, feel themselves to be in the grip of powers quite outside their control, This, however, is a feeling common to all of us, in an international sense by the political aspirations of different countries, and in a national sense by the political aspirations of different organisations, particularly in these days of mergers and take-overs.

We all thus have basic feelings of insecurity which are clearly much worse for those who feel they can be relatively easily replaced; as this covers the large majority of those in industry, the effects on human relations can be profound. Wherever this basic sense of insecurity is realised and fully appreciated by management, happier working conditions almost inevitably result.

If basic insecurity can be removed or sensibly reduced the field is open for co-operation with the employees, but the main responsibility for getting this going is with management, which is clearly always in a position of the greater security and always in the position of receiving the greater gain. Co-operation means consultation, a factor which in itself goes far to relieve insecurity, but consultation will never mean very much if goodwill does not exist in the organisation. Goodwill can only result from positive management policies designed to that end.

The nature of employment has been significantly modified by the advent of full employment, and while it may be true that some managements would wish that there always was what they would call a "healthy" pool of unemployment, I cannot believe that the more important managers, those controlling the larger organisations, would do other than fully support the policy of full employment. To this degree I don't agree with Lewis Wright, Secretary of the Amalgamated Weavers' Association, when he said at the Production Conference at Olympia, May 1958: "Most employers or managers protest that they have no time for theoretical abstractions as they are fully occupied in producing the goods and making a profit. Most of them haven't the faintest idea how to achieve results making for maximum efficiency; . . . any problem that cannot be worked out on a slide rule is dismissed as 'labour trouble' and the cure prescribed is 'a dose of unemployment to bring them to their senses.' "

One good effect of full employment is that it leads to a greater weighting of employees' views and a greater value therefore from consultation.

the trade union position

Probably the most difficult problem facing trades unions is the poor attendances at branch meetings. There would appear to be no prospect of improvement in this regard; indeed, the indications all point to the position getting progressively worse, since there is a positive shift of power from the branch secretary to the shop steward on the shop floor and to the works convenor. The branch originally was the unit of craft unionism, but with the rise of the semi-skilled worker, the place of work rather than the craft has become a more important logical unit of organisation.

Average attendances of 4% to 7% of membership is common, with often still fewer for widespread organisations like the A.E.U. and T. & G.W.U., and others. (In some industries like mining and printing the branch and the shop are the same unit and the difficulties of separation do not apply.) Mr. Woodcock, President of the T.U.C., has said that branches have ceased to be an important part of trade union structure. Executive authority in the trades unions flows down the official machinery to the branch, while the flow of workshop grievances goes up to the shop steward, who probably never attends a branch meeting; there is thus a complete break in communications between the shop steward and the branch. Both the individuals concerned are likely to be much too busy to be able to do much about this and the stewards' most likely official contacts are apt to be with other unions' shop stewards. The troubles in the docks and in the motor industry are not helped by lack of regular contact between branch secretary and shop steward.

the Communist influence

The general apathy of union members to their branch meetings, and the ever-growing power of shop stewards creates fertile ground for Communist activity, and in thinking of such activity it would be well to impress upon ourselves the words of Lord Citrine, who in an address as Chairman of the Central Electricity Authority on "Human Relations in Industry", given to the Institution May 1955, said: "Communist Party members believe in the collapse of capitalism and that to achieve this there must be class war. They are, therefore, continuously fighting against good human relations with managements and between men anywhere in industry—they must stir up trouble and keep up unrest. They believe that because of this 'class war' the industrial system must be kept in continued commotion; that it must not be allowed to settle down and every dispute is exploited to hasten the day of collapse."

There is no doubt that future industrial relations must depend upon an acceptance that shop stewards are a significant operating factor in industry. It is as much in the interest of management as it is in the interest of trades unions to ensure that a reasonable working arrangement, based upon a strong shop stewards movement, can be achieved; management and trade union officials should get together on this.

An important point in connection with trades unions is their number. There are over 600 operating in the United Kingdom and this is far too many. I am afraid I can offer no suggestions here, but perhaps you have comments to make. Another factor against trade union development is the relatively small subscription paid by members.

general industrial developments

The effective arbiter of industrial relations must be the larger sized unit and from it must flow the codes of industrial behaviour which will be accepted and adopted by all working units, this notwithstanding the fact that more than half the industrial population work in factories with fewer than 500 employees.

A very high proportion of employees work in establishments where a professional salaried manager is employed, a manager whose personal stake in the

business is slight. It is thus that the professional manager has taken away from the man of wealth the power that is implicit in running a business.

To quote from J. K. Galbraith in "The Affluent Society": "When the rich were not only rich but had the power that went with active direction of corporate enterprise, it is obvious that wealth had more perquisites than now. For the same reason it stirred more antagonism. J. P. Morgan answered not only for his personal wealth, but also for the behaviour of the United States Steel Corporation which he had put together and ultimately controlled. Today the shares of the United States Steel Corporation are still the foundation of several notable fortunes. But no sins of the Corporation are visited on these individuals, for they do not manage the Company and almost no one knows who they are. When the power that went with active business direction was lost, so was the hostility.

"It does seem clear that prestige and power are now far more intimately identified with those who, regardless of personal wealth, administer productive activity. The high corporate official is inevitably a man of consequence. The rich man can be quite inconsequential, and often is."

The professional manager, taking the job as a job and using all the scientific aids possible to give him the analytical tools necessary to provide information, must surely be less likely to founder in a difficult industrial situation with the plant community than the owner-manager, who might feel he is too important to be pushed around. The owner-manager will be less likely too to consider that the job requires modern scientific techniques of every kind, and would be more likely to "fly by the seat of his pants", "to play it by ear", than would the professional manager. This use of professionals must progressively improve management generally and this improvement will spread; indeed, *it might be said to be contagious.*

Another aspect of industry which will profoundly change industrial life is the advent of automation, the so-called "second industrial revolution". It should not be imagined, of course, that every factory will be operated by press-buttons—far from it; the necessity for batch production, where the expense of automation is simply not worthwhile, will always be responsible for a very large proportion of industrial output. Many factories, though, where batch production is now the order of the day, will be linked together with other similar factories and their production rationalised into mass production quantities under the force of the company mergers and take-overs so common today. In this sense, many factories which left alone would never have the need to bring in automation, will do so by the merging of common interests and all will be compelled to install special purpose machine tools to reduce man-power to a minimum; this is probably the simplest form that automation can take.

All these developments will take time, but will nevertheless present problems of a major character to all of industry. While they will take a long time, the important question is, how long also will a reasonably good understanding grow of the social sciences of industry? What will the rate at which the social sciences become sufficiently understood be in relation to the rate at which the second industrial revolution effectively takes place, and effectively displaces sufficient man-power to be really troublesome?

personnel problems in the plant

Stuart Chase has said: "A factory performs two major functions—the economic one of producing goods and the social one of creating and distributing human satisfactions among the people under its roof".

We may have for too long neglected the development of human satisfactions in a plant but we are at the time now, or ought to be, when a measure of successful plant operation will be recognised by a high community interest in the total organisation and an active participation by the employees in the social aspects of their groups. It is becoming fashionable, of course, to have one's Company labelled as "progressive", but much more is required than elaborate brochures on Company policy, and fancy titles in the personnel office. The feeling in a plant stems from the personalities involved and this naturally starts with the manager; if he, with his top echelon of management, form a good working team, with not too much distance either in position or salary from them, with community interest bedded into their thoughts, the plant is well on the way to high community interest.

It should be thoroughly understood, throughout the whole plant, that the only factor that justifies the continued existence of the plant as a producing organisation is economic performance; this is and must be the first responsibility of management, however management is derived. Any manager who neglects this as his first responsibility should be condemned by the whole plant, as its very existence in the years to come, its ability to offer continued and stable employment, depends upon this alone. To a degree which might be marked, the need for economic performance and the individual welfare and interest of the employees could be in conflict; e.g., the advent of automation; but there is no escape from the need for economic performance.

What we have to contrive is that economic developments cause the least individual disturbance possible, disturbance which also should be as temporary as possible and be properly compensated. History shows that industrial development has always progressively improved material well-being and not less so in the case of the average working man; there is no reason why this should cease, or indeed, slow down.

As has been mentioned, the larger organisations set the general industrial pattern and the larger organisations have the greater difficulty with the development of community interest, simply because of their size. In this sense of size I am taking the dividing line between large and small to be 500

employees; this has been quoted as probably the figure at which the manager begins to lose personal contact. The difficulty of the larger units is that of communication and more often the difficulty of communication up from the shops and office floors: this is a real difficulty and there would appear to be no ready solution. It is often claimed that the difficulty lies mainly in the area of middle management, but what is defined as middle management will vary with each organisation and particularly with size. It is not my experience that middle management creates a block in communications, though I could well believe it to be possible. We are all seekers after knowledge in this complex matter.

Let us briefly look at the position existing in the average large-sized working community, one that by its size will give us difficulties of communication and will again, because of its size, be a pattern influencing other organisations.

The large bulk of the employees will have a basic feeling of insecurity and be ready to pick up any rumour of change going around the plant; rumours of redundancy, reduction in output, changes in current orders, process modifications: all are unsettling to the average employee and to a degree that would appear not to be fully appreciated by average management.

There is likely to be a shop stewards' organisation progressively gaining in power and probably with poor communications with the trades unions concerned, which might be many—too many.

There may well be a personnel department reporting to a centralised personnel management at a distant plant, or a set-up generally where delays in settling personnel problems are inherent in the system.

There will probably be a fair measure of misunderstanding in the plant on the Company's economics, and the profits and their distribution will come in for the usual adverse comment, usually wholly unjustified.

Top management will seem remote from the shop floor workers, who may have difficulty in concluding that their problems can be appreciated at what they will think of as the "distant heights".

Taking all these factors into consideration, one can conclude that there might well be more trouble than has actually been the case. It is certain, however, and should be clear to any management, that with so many possibilities of going wrong it is fatal to rely on instinct; to do nothing positive and to hope for the best. Positive employment policies must be pursued and must be continuously applied, often in the face of what may well be considered by management as base ingratitude.

trends and developments

It is my belief that many, and I think the majority of managements, are doing a great deal to handle sensibly the human problems of industry which confront us. The great depths of the problems are not so well seen, but with a marked increase in awareness of the humanities on all sides in industry, with the general willingness of the average working man to play ball in response to reasonable treatment (and I would like particularly to stress this point), we can feel assured that the developing situation in this regard is one of promise. I am certain that one of the prime requisites for the better treatment of the average employee is the feeling that we are progressing generally in the improvement of human relations in industry. Every manager trying for better understanding of his human problems should go ahead in the full confidence that he is making a contribution to a sensibly improving whole; having this confidence he can more easily impart it to his employees; as I have said before, the feeling is contagious.

We have learnt that to consider one's responsibility fully discharged by paying an employee his or her emoluments for work done is not by itself enough, even upon the basis that the payment is a fair return for services rendered. An employee requires status and function, in order to experience the human satisfaction of doing a job with a meaning beyond the pay packet. The employee will naturally find a level with his fellow-workers which will reflect his own personality; his position in the working community of the plant should be aided rather than retarded by the work he is called upon to do and by the conditions under which it is to be done.

importance of personnel departments

The problem of communications has really to be tackled and while the first requirement is certainly a sympathetic management, of immediate importance is a first-class personnel department, one on which management is prepared to spend a good deal of money—as much, in fact, as upon departments controlling technical improvements. The department should be built up with care and comprise a group of dedicated people with a practical outlook on life, and a liking for people—and I don't mean by this that they should not have had a good academic training; rather the reverse, since it does not at all follow that a person with a good academic background is not practical. I have heard it said, and can well believe it to be the truth, that the U.S.A. is well in front of Britain in the care and money spent on personnel departments.

It is essential, for example, that the personnel department operates with maximum authority, that it is sufficiently well staffed to be able to deal promptly with employee difficulties and that the staff have ready access to the top manager to whom the department should report.

So far as it is possible to contrive, the personnel departments in separate plants should be able to deal directly with their problems and without delay. Any reference back through a chain of command, where it is obvious that the department has little authority, will result in a loss of respect which can be fatal to the proper settlement of personnel problems.

I have mentioned the developing power of the shop stewards, a power which, since it is developing naturally from the industrial circumstances of the

case, should be used by management to improve the lot of the working man. A manager should develop in his plant a strong shop stewards' group while at the same time keeping close contact, and friendly contact, with local trade union officials.

It is usually the case in a plant of any size that the front line of management, the foremen and assistant foremen, have been sent away for training of some kind which has included in its syllabus basic economics and industrial human relations. On the front line it is essential that the relationship between foremen and shop stewards should be as good as it can possibly be made. Very often the shop steward is not the best man in the shop and more often it is the one person willing or cajolable who gets "elected"; this doesn't help. It is a good idea, in my view, to encourage training courses for shop stewards, to help in raising the general level of knowledge and so improve the intake. Such courses are not readily available, though the T.U.C. does all it can in this regard and a number of educational establishments also co-operate. It is also the case that the shop steward cannot be expected to have time off at his or her own expense, and management is left with the problem of laying on courses which can be approved by the shop stewards generally, preferably organised by an independent body, and run in works time. We have ourselves been able to propose such courses and I am greatly indebted to the Extra-Mural Department of our local university, which has become the sponsoring body. Our local trades union officials have been brought into the picture and are giving their blessing; the scheme is experimental and we hope for success which will encourage others similarly.

In recommending a strong shop stewards group in the plant, I would not have it thought that the power of the foreman should thereby be reduced. In every possible way the foreman should be made a positive part of management, advised continuously of all management policies and studiously consulted before information gets to the shop floor. He has, of course, lost some of his bowler-hatted authority; he is no longer a demigod of the shop but he is gaining, or should be gaining, in knowledge of company policy and in closer links with management.

a self-governing community

A trend in the U.S.A. which confers status on employees is the development of a self-governing plant community. I am not aware that this has been done to any extent in Britain and I should be glad to learn of examples; the matter has been quite fully covered by Peter Drucker in his book "The New Society" and I quote largely from this source.

What is meant generally is that those areas of company activity not directly associated with economic performance are given over, either wholly or in part, to employee control, with management acting in an advisory capacity. These areas cover transportation to and from work, parking, canteen, sports clubs, hobby clubs, etc., and educational activities; while they are usually under the control of the personnel department, they need not be; they can be given over to employees to run. Holiday schedules and shift assignments might also be included in employee responsibility, since here management is primarily interested in the job to be done and not particularly who does it. These areas of employee control should be autonomous and what they might lack in importance from the point of view of the economic performance of the company, is more than made up for by the intensity of feeling they arouse. The transfer of responsibility and control on these matters from management to employee can remove a source of particularly intense irritation and anti-management feeling. With any of the above arrangements working well, more might be attempted and, for example, safety and health matters could be considered and made largely the concern of employee groups.

Similarly, training, absenteeism, labour turnover, plant discipline and plant rules might be made joint efforts, the personnel department being here equally concerned with effective performance. What can develop from such further transfer of control is an autonomous self-governing plant community; a legitimate government, still subordinate to the principle of economic performance by management, but able to run its own affairs and with its own authority and officers.

co-partnership and profit-sharing

It is often thought that markedly better personnel relationships automatically follow from co-partnership and profit sharing, but these schemes have not met with marked success. Let me quote from "The Bargainers" by George Cyriax and Robert Oakshott:

"In 1955, when the last Ministry of Labour survey was conducted, only 310 private profit-sharing schemes were in operation; they covered only 345,000 employees or 1½% of the civilian labour force (Co-operative societies are not included). Many early profit-sharing schemes were disbanded during the depression of the thirties when there were no profits to share; others lapsed through apathy; and 75 of the 605 discontinued since 1900 were turned into awards of higher wages. Since 1955 the number of workers covered has increased, thanks largely to I.C.I. who in 1954 introduced a major profit-sharing and share-distribution plan covering 75,000 of its permanent employees. By 1965 the number is likely to be considerably higher again. But without any doubt, the record is disappointing all the same."

A completely new approach is proposed by J. K. Galbraith in his book "The Affluent Society", in writing of the U.S.A. in terms which state his view that the U.S.A. is producing more than its needs in consumer goods and should turn to the production of other things; such things, for example, as will produce greater human satisfactions, or improve man's chance for survival. It should follow any or all of three choices: work fewer hours or days in the week; work less hard; arrange for fewer people to work all the time.

Galbraith claims that the marginal urgency to produce goods is declining and points as positive

proof that in 1850 hours of work averaged just under seventy per week—in 1950 the average was forty (U.S.A.). He now suggests that we could also make work more easy and pleasant. He further suggests that we could have more unemployed and more people at an earlier retiring age and consequently out of employment. Our affluent society, he claims, can afford more unemployed and can afford to give them all they need in the way of a satisfactory living standard.

He continues, and I quote :

"It is a measure of how little we need worry about the danger from reducing the number of people engaged in work *qua* work that, as matters now stand, our concern is not that we will have too few available for toil, but too many. We worry lest such technical advances as automation will proceed so rapidly as to leave a surplus of those who still work. This, indeed, could be the great danger.

"Why should men struggle to maximise income when the price is many dull and dark hours of labour? Why especially should they do so as goods become more plentiful and less urgent? Why should they not seek instead to maximise the rewards of all the hours of their days? And since this is the piain and obvious aspiration of a great and growing number of the most perceptive people, why should it not be the central goal of society?"

Why not indeed!

I have mentioned this trend in the U.S.A. to indicate developments in what is probably the most advanced industrial society in the world, at least in the material sense. It surely is arguable that having achieved material well-being to the degree they have done, something more can be done to achieve a greater level of human satisfactions. Can we look to such developments generally?

We have been discussing in this Paper aspects of human nature and as Galbraith says, the problem of explaining human nature lies in what human nature wants to hear, of what it finds acceptable; it will find acceptable what is most agreeable and in a general sense there doesn't seem any way out of this. If the truth is in any sense disagreeable, if it requires effort to understand, if it promises some dislocation of life as it is then being lived, it will be discounted, distorted and in some way dodged. People will accept and approve of those things easily and best understood, and since social behaviour is exceedingly complex and difficult of understanding, it will be accepted only in part and generally the simple explanation preferred.

We cannot of course, complain that human nature is human; we can perhaps understand that we are limited by our natures from a full appreciation of human problems and if our understanding goes so far as to permit us to exercise the great human virtue of patience, much will have been achieved.

THE "NEW APPROACH" TO PRODUCTION

by JOHN L. BURBIDGE,

A.M.I.Mech.E., M.I.Prod.E., M.B.I.M.

Mr. Burbidge is well known as a writer on Production Control and for his outspoken criticism of Batch Quantity Analysis.

Educated at Wellington School, Somerset, and Cambridge University, he entered industry as a student apprentice with The Bristol Aeroplane Company. Since then he has had 25 years of practical experience in management, in posts as varied as Shop Manager, Chief Inspector, Chief Planner, Sales Manager, General Manager, Works Director and Managing Director. He has an equally wide experience of different products, including aero-engines, marine engines, agricultural machinery, printing machines, cars, wire, tractors, steel house frames, and plastics.

Mr. Burbidge, who is now a consultant in Industrial Engineering and Management, is the author of a book, "Standard Batch Control", and has also written a text book of Production Control which will be published shortly.

TO production historians of the future, the 20th century will be known as the "Age of Waste". An age when much of the wealth invested in production was stored away unused in the form of stock; an age when a large part of the labour force was wasted on the unproductive processing of administrative paper work; and an age in which most of the production capacity was left unused for long periods, due to our failure to control the demand cycle.

Production has reached a stage where normal evolution along traditional lines, only increases this waste. It has reached a point where substantial progress is only possible if we can find a new approach.

This Paper describes a possible approach. It advocates the use of high batch frequency line flow, for all types of product and for all levels of output. Such systems are already in use in mass production. It is here submitted that they have a universal value, irrespective of the volume, or type of product.

The Paper attempts to show that the New Approach is both theoretically sound and possible in practice. It is divided into four parts. Part I describes the material flow system, which is "production". Part II shows how material flow is related to the economies of production. Part III shows how our present philosophy of management tends to perpetuate the *status quo* and, finally, Part IV develops the philosophy of the "new approach", and describes how it can be, and has been applied in practice.

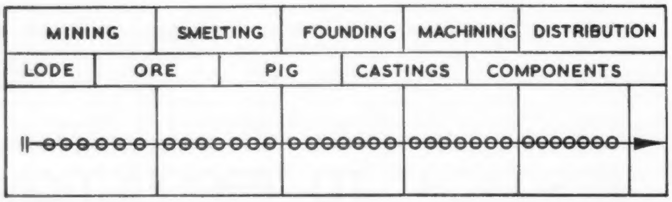


Fig. 1. Process chart for single component

the material flow system

1. process sequence

The word " production " covers both the manufacture and the distribution of goods. The common feature which links both these parts of production is material flow. All production is concerned with materials, with the work done on them, with the changes in material " state " caused by this work, and with the economic effects of this " flow " of materials.

The choice of work operations and their sequence can be illustrated by a process chart. Fig. 1 is a process chart showing the sequence of operations required to produce a simple cast iron product. It illustrates the way in which the " state of materials " (their form, weight, location, and so on) is changed, and the way in which the flow of materials can be handled by a number of different companies, each carrying out one " process ", or sequence of related operations.

Very few process charts are ever as simple as Fig. 1. Most of the chains of operations found in practice are cross-linked in various ways. Operations can be classified according to their effect on the material flow streams, into " dividing operations " which divide a large stream of material into a number of component streams; " combining operations " which combine a number of streams into one larger stream ; and " flow operations " which leave the volume of flow unchanged. Fig. 2 now shows a number of component process charts and the way in which they are linked together by dividing and combining operations.

For any production unit, it is possible to draw a " total process chart ", showing all the operations done, their sequence, and the way in which they are cross-linked. The complexity of the chart can be reduced by adopting policies of " simplification ", to reduce diversity and thereby reduce the number of operation chains on the chart.

2. the flow system

The choice of operation generally prescribes or limits the choice of "work centre". Work centres are places where work is done, which are equipped with the necessary plant, tools and equipment and manned with the necessary labour to carry out certain types of operation. The general case is one in which work centres have fixed locations and materials move between these fixed centres. There are other cases where the relative motion of plant, men and materials is different, but these changes do not affect the conclusions reached.

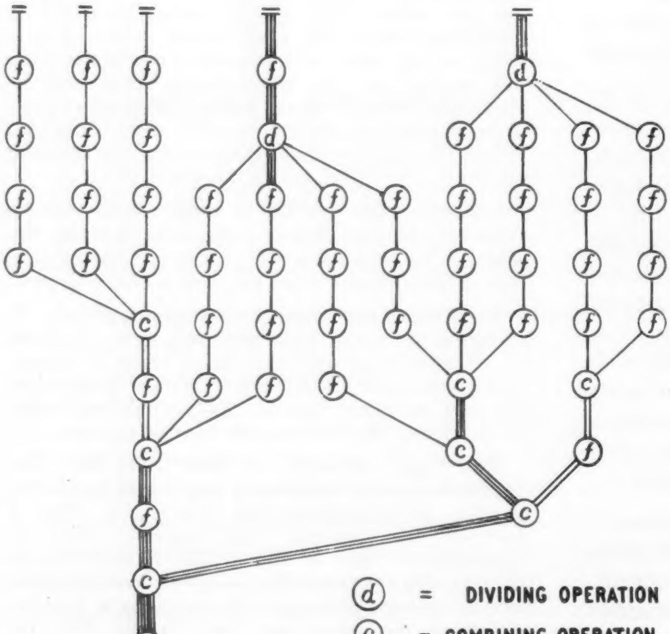


Fig. 2. Related process charts for 11 components

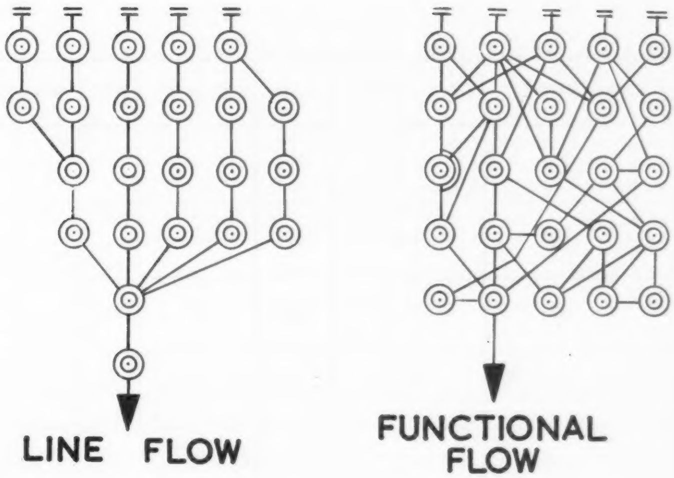


Fig. 3. Effect of plant layout on type of flow

If a map is drawn showing a production unit and the work centres contained by it, and if a Total Process Chart is then drawn on the map, with each operation shown in the position of the work centre on which it is done, the result is a "Total Flow Chart". The degree of complexity of such a chart is partly controlled by the complexity of the Process Chart, and partly by the way in which the work centres are "laid-out". For example, Fig. 3 shows diagrammatically the type of flow known as "line flow", which is obtained if the plant is laid-out roughly in the sequence shown on the Total Process Chart, and also the type of flow known as "functional flow" which is obtained if the plant is laid out in specialist groups according to function.

In most of production today, the Total Flow Chart illustrates the chance result of the independent decisions of separate specialists in product design, in process planning and in plant layout. This is not the only way and is certainly not the best way of designing a flow system. It is quite possible to direct and co-ordinate decision-making in these three fields in order to design an ideal flow system, and to do so without reducing the operational efficiency of the product.

3. *the characteristics of material flow*

The combined effect of product design, process planning and plant layout, is to produce a material flow system or channel system. The way in which materials are "dispatched" through this system can be varied. It can be shown that all material flow is in batches, and that this batch flow can be varied in batch quantity, batch frequency and phase.

(a) BATCH QUANTITY AND BATCH FREQUENCY

As a general case, consider the flow of components in a production unit, where the batch quantity is measured in units of the piece and each batch of material is completed at each operation before work starts on the next operation.

The output obtained equals the product of average batch quantity and batch frequency. For any given output rate there is a very large number of different batch-quantity batch-frequency combinations which can be used. For example, Fig. 4 shows a few of the possible combinations which can be used to attain an output of 1,200 pieces per annum. The limiting combination where the batch quantity is one piece is known as "line production". Generally it is only possible in a line flow channel system.

(b) OTHER CASES

The general case has been considered in which the flow is in units of the piece and all the pieces in a batch are finished at each operation before work starts on the next one. It can be shown that this idea of batch flow is a universal concept which can be used to cover all types of flow.

For example, if the materials are liquids, or gases, or aggregates of unlike particles, or long continuous filaments of wire or strip, the piece is an unsuitable unit, A change of unit does not destroy the validity of the concept of batch flow, even if the units are joined together.

Again if buffer stocks are held between operations, if the nett transfer between operations is "Q" units of material, then the batch quantity is still "Q" however the transfer is arranged. It is the same if the buffer stock is left untouched; if the finished parts at one operation go into a common pile with the buffer stock and the material for the next operation is selected at random from the pile, and again if the buffer stock forms an orderly queue.

"Close scheduling", where following operations are started before the preceding operations are complete, does affect the batch quantity. In the limiting case, if each operation were started immediately one unit of material had been completed at the preceding operation, the batch quantity would be "one".

	Batch Quantity	*Batch Frequency*	*D*	*Jan.*	*Feb.*	*Mar.*	*Apr.*	*May*	*June*	*July*	*Aug.*	*Sept.*	*Oct.*	*Nov.*	*Dec.*
a	1200	1 p.a.	1200												
b	600	2 p.a.	600						600						
c	300	4 p.a.	300			300			300			300			
d	100	12 p.a.	100	100	100	100	100	100	100	100	100	100	100	100	
e	50	24 p.a.	50	50 50	50 50	50 50	50 50	50 50	50 50	50 50	50 50	50 50	50 50	50 50	50
f	1	1200 p.a.	1												

Fig. 4. Alternative batch quantity/batch frequency combinations to achieve a fixed output (in all these instances the output rate is 1200 p.a.)

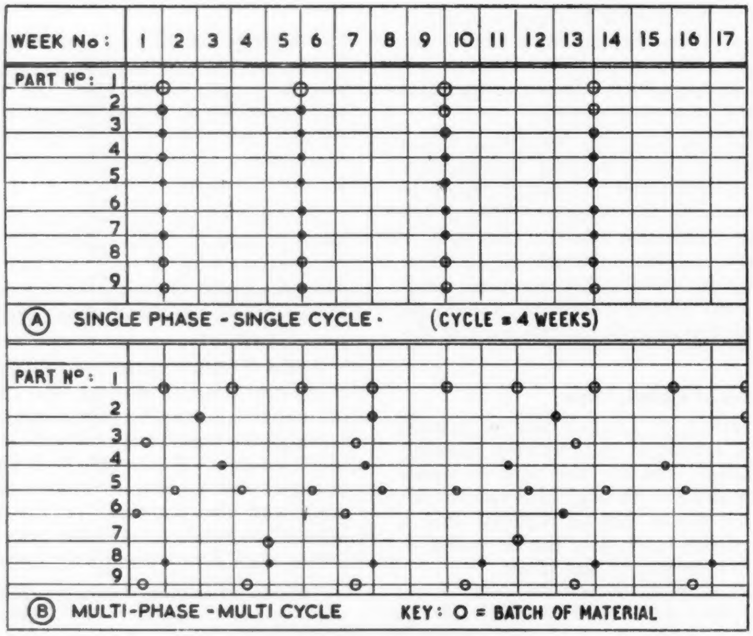


Fig. 5. Types of flow—differing in phase

(c) PHASE

The third "parameter" controlling the characteristics of material flow is "phase". Considering the way in which batches of different components are "dispatched" through the flow system, it can be shown that there are two limiting types of "single-phase, single-cycle" and "multi-phase, multi-cycle" flow. These are illustrated in Fig. 5.

Single-phase flow is the type in which all the components required to cover a given period of time, are ordered together for completion by a common due-date. It is the type of flow associated with production control systems such as "Period Batch Control", "Standard Batch Control", "Base Stock Control" and with "Line Production".

Multi-phase flow is the type in which every component has its own special batch quantity, order date and due-date. It is the type of flow associated with "Batch Quantity Analysis" and with such production control ordering systems as "Stock Control" and "Component Batch Scheduling".

(d) STOCK

All production systems generate stock. It is impossible to have production without materials and stock is merely a measure of the amount of material in the system. There are three main causes for the generation of stock in a production unit. They are:

lack of balance between input and output;
protection policy; and
the characteristics of material flow.

(i) stock due to lack of balance

At any point in the flow system, any unbalance between input and output will change the stock level. In practice the management in any single production unit should at least be able to control material flow so that this type of stock only arises at the product outlet end of the system. Its value depends on the relationship between lead time and finished product delivery time and on the variability and predictability of demand.

(ii) stock due to protection policy

At any point in the flow system buffer stocks may be held as an insurance against the possibility of a plant breakdown, a failure in supply, or an unpredictable variation in demand. The amount required to give adequate protection against an interruption in flow depends partly on the efficiency of plant maintenance, buying and processing, and partly on the characteristics of material flow, insofar as they affect the speed of material replacement.

(iii) stock due to characteristics of material flow

The characteristics of material flow — particularly batch quantity — are the most significant factors controlling the level of stock. Consider a raw material item, received into and issued from a raw material store at the constant rate of 1,200 tons per annum. If this is supplied in two batches of 600 tons per annum, the average stock will be 300 tons; if supplied in 24 batches of 50 tons, the average stock will be only 25 tons instead of 300. It is much easier to demonstrate the effect of the material flow characteristics on stock in economic terms of monetary value and this is the next matter to be examined.

the economics of material flow

1. stock value

The change in cost value of a batch of material, in relation to time, can be illustrated by means of a "stock chart". Fig. 6 shows such a chart illustrating the change in cost value of the stock during the life of a batch. The height of the plateau on which the chart is drawn represents the buffer stock and the remainder of the chart shows the stock induced by the characteristics of material flow.

It is assumed that the batch quantity in which the material is received from the supplier is the same as that used in processing. This simplifies the "model" for exposition, without damaging its universal validity. By using total cost (actual cost) for valuation, the stock value can be made the same as the "investment".

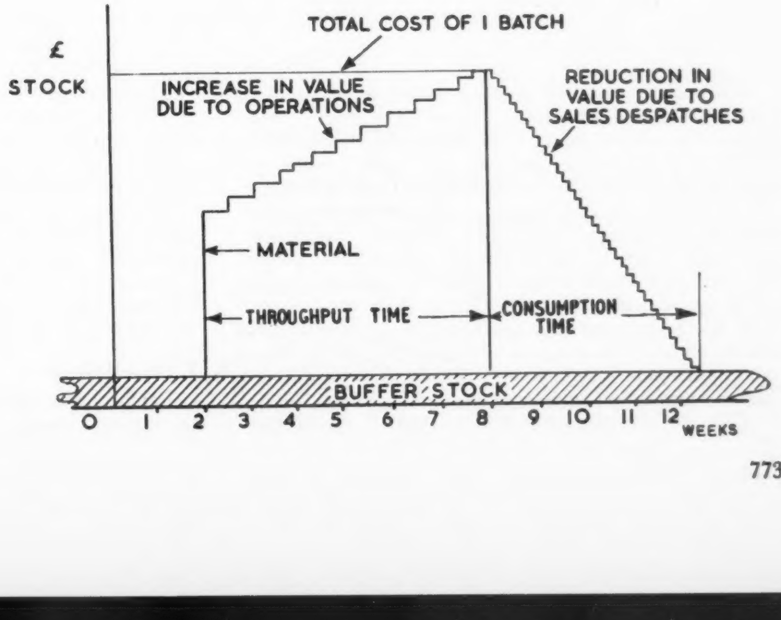


Fig. 6. Stock chart for a single batch

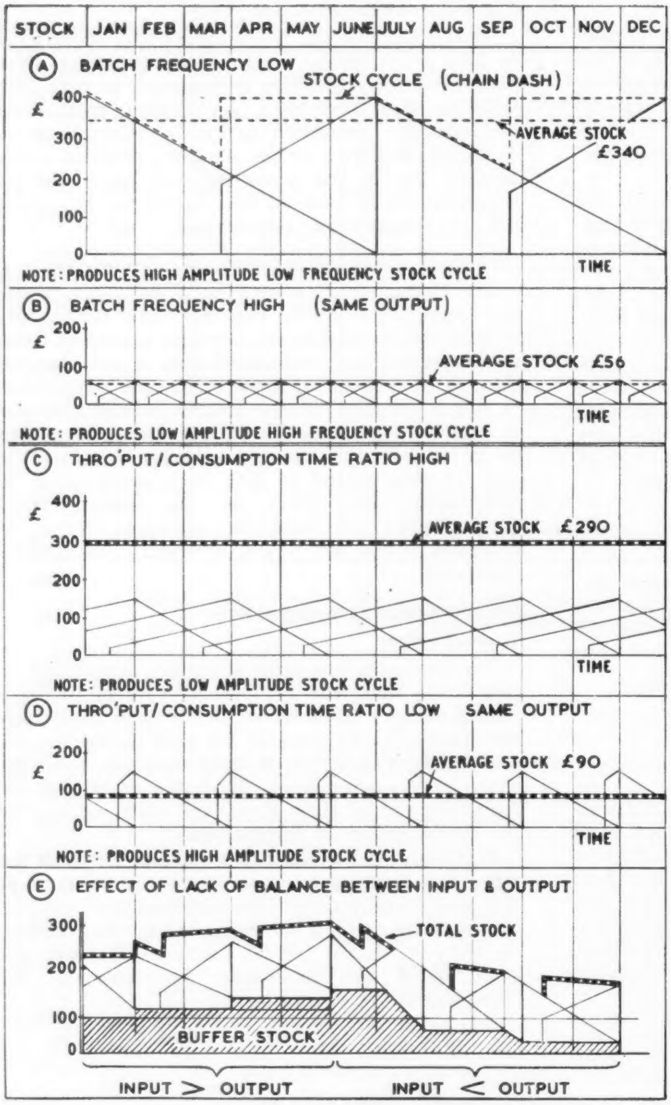


Fig. 7. Component stock—effect of batch frequency, stock chart shape and input/output balance

If a number of batch charts is arranged in a series to represent the continuous output of a given component, it will be found that the average stock is a function of the batch quantity, the batch frequency and the shapes of the batch charts. These relationships are illustrated in Fig. 7. It will also be observed, that the same factors of batch quantity, frequency and shape, control the amplitude of variation about the average. High batch frequency systems, have stock cycles with lower amplitude than those with high batch quantity and low batch frequency. Batch charts with a low ratio of throughput time to consumption time (typical of distribution), produce higher amplitude stock cycles, than those with a high ratio. Diagram "E" in Fig. 7 shows the effect of lack of balance between input and output, on the stock. Balanced flow occurs when the consumption periods for succeeding batches end and finish at the same moment.

If the stock curves for all the different components using a flow system are now combined to find the total stock generated by a given flow rate, it will be found that the characteristics of variation are governed partly by the amplitude, frequency and symmetry of the component stock curves, and partly by the phase relationship. Fig. 8 shows the effect of phase on Total Stock. Multi-phase systems tend to generate unpredictable and erratic variations in Total Stock, due to the drifting in and out of phase of the peaks and troughs of the component stock curves. They also tend to generate higher stocks than single-phase systems. This is partly because they cause obsolescence and lack of "set" Balance in the Stock, and partly because single-phase flow can be controlled at much higher batch frequencies.

The types of variation described above occur even at constant output rate. If batch quantity and/or batch frequency, are now allowed to vary to match a fluctuating demand cycle, the stock variation will be still further exaggerated as shown in Fig. 9.

This type of "model" can be used to represent the stock variation in any type of production, whether concerned with manufacture or distribution. It is possible with a computer to simulate the effects of different types of change and thus test their effect on the stock and investment in production.

2. capital tie-up

Batch charts can also be used to show the changes in capital tie-up imposed by individual batches,

reflecting the flow of money in the business rather than the changes in value of the physical stock. Fig. 10 shows a capital tie-up chart and illustrates the effect of credit. These charts can be used in exactly the same way as stock charts, to simulate the effects of different types of material flow on the capital of a company.

3. cost

The shapes of the batch charts are defined by the batch values for cost, throughput time and consumption time. It is now necessary to consider the link between the values selected for types of flow system, batch quantity, frequency and phase, and the induced changes in the batch charts. In a complex system of thousands of inter-related variables such as production, it is impossible to deduce exact quantitative relationships to link individual changes in the parameters of material flow with money flow. Such attempts must be pseudo-scientific because the sub-systems cannot be isolated and tested. There is, however, a wealth of practical experience, or evidence, from which it is possible to "induce" the principles governing the direction of change in the economic variables (cost, investment, return, profit and so on), which will be caused by a given direction of change in parameter value. Here only direction of change will be considered.

Three of the principal factors which affect cost are design, process planning and plant layout. These are the same factors which control the type of flow

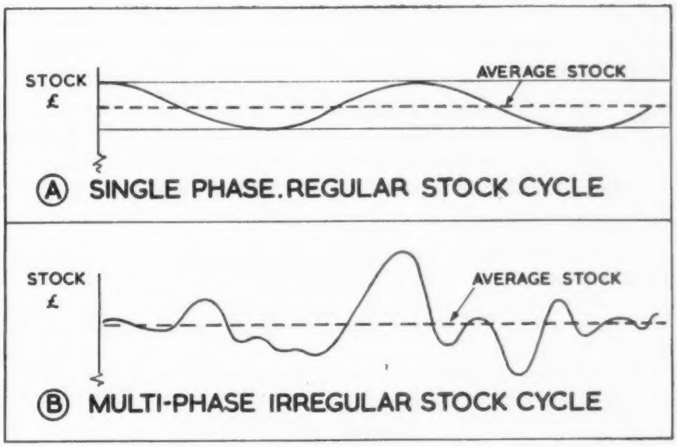


Fig. 8. Effect of phase on total stock cycle

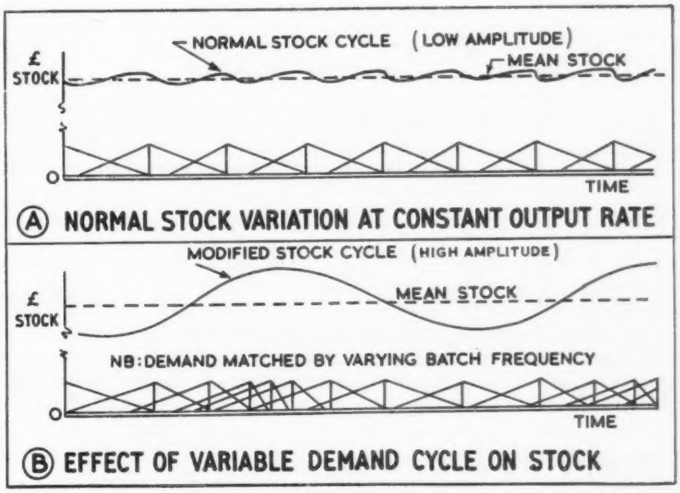


Fig 9. Effect of demand cycle on normal stock cycle

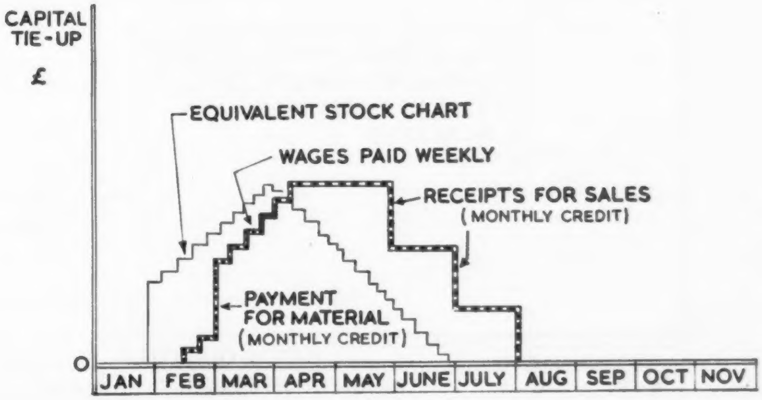


Fig. 10. A batch captal tie-up chart

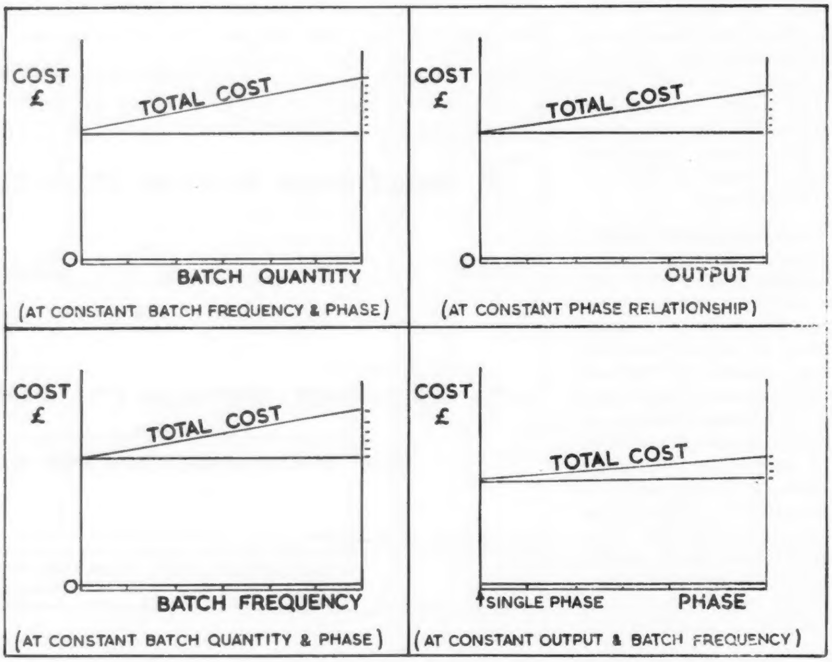


Fig 11. "Direct" changes in cost due to changes in flow parameter

system. It is a common experience in production that improvements — or in other words a reduction in complexity — of the flow system, tend to reduce total costs. There are obvious reasons for this reduction in the lower costs of handling, administration and storage, which arise as a result of better flow. It can be " induced " from experience that those decisions in design, production planning and plant layout, which tend to contribute to an improvement in the flow system, will also contribute to a reduction in Total Cost. It may be that decisions which promote good flow will increase direct labour cost, or other components of total cost in particular instances; it is submitted, however, that *the best decisions inside the limitations imposed by good flow, will tend to promote lower total costs than the best decisions without this limitation.*

Considering now the changes in batch cost caused by changes in the parameters of batch quantity frequency and phase, it is necessary to recognise

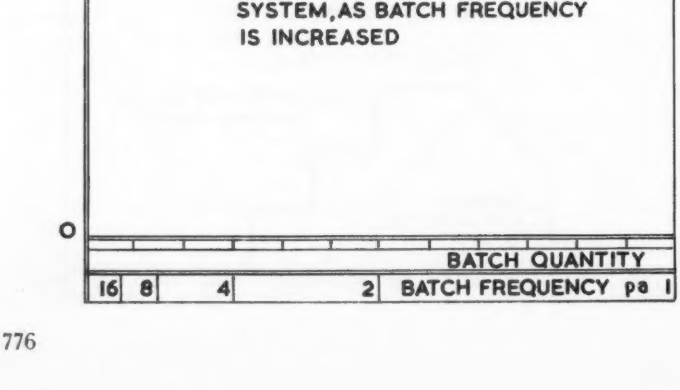


Fig. 12. "Direct" changes in cost due to batch quantity change at constant output rate

that there are two principal types of change: "direct change" and "potential change". Direct changes are those induced automatically by the relationship between the variables in the existing system. Potential changes are those which are made possible by parameter change, but can only be realised by executive action which changes the system. The savings due to "potential" change are those which are lost due to Parkinson's Law, unless direct action is taken to achieve the potential.

The "direct" changes in Total Cost with changes in batch quantity, batch frequency, their product output, and phase, are illustrated in Fig. 11. In all cases there is a large element of fixed cost and a smaller element of variable cost. The elements of Total Cost which are variable, are, however, different in each case. Because the batch quantity and batch frequency scales are closely related, it is possible to show the effect of combined change at constant output rate on one chart, as in Fig. 12. That the flat shape of this curve is typical can be tested by analysis of company trading accounts, analysing the effects of changes in batch quantity and batch frequency on each of the large number of different cost items, using the same technique as is used in the preparation of a break-even chart. It is submitted that *changes in batch quantity at constant output rate, generally have an insignificant "direct" effect on total cost, over most of the possible range of batch quantities.*

The reduction in cost due to change of phase is partly due to the simplification of control and partly to the reduction in obsolescence, when single-phase flow is employed.

The "potential" changes in cost due to changes in batch quantity, frequency and phase are best illustrated by an example. Fig. 13 shows the administrative paperwork required to order and control the production of one batch of one component, in a

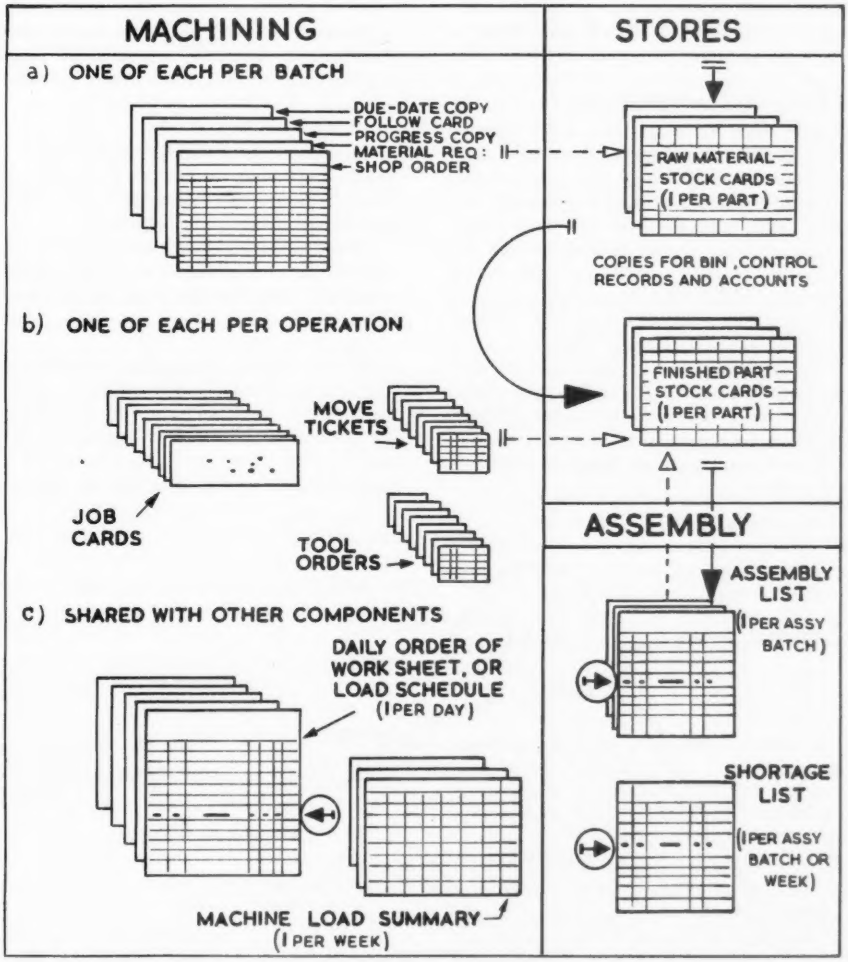


Fig. 13 Paperwork required for one batch of one component, with low frequency, multi-phase flow and functional layout

machine shop where the plant is laid out on a functional basis and a multi-phase ordering system is used. Because there is no fixed route for all material flow and because all components have different start-dates and due-dates, all this paper is necessary. It is possible in a line flow system using single phase ordering, to control the whole flow of all components with only one or two copies of a single " list order " each period. The potential saving in indirect labour and expense is enormous. Generally, in the present state of industry and commerce, the " potential " changes in cost due to changes in flow parameter are more significant than the direct changes. The cost of administration and control is very much less with line production than with any other type of flow.

There is a close relationship between phase and batch quantity. In the limit when all batch quantities are " one ", single-phase flow is the automatic result. Each reduction in batch quantity reduces the degree of out-of-phase. Considering both the " direct " and the " potential " changes in cost induced by a change in batch quantity, it can be stated as a principle that: *the " total " effect of reducing batch quantities at constant output rate, is to reduce total cost.*

4. throughput time and consumption time

The throughput time for a batch can be divided into components of " waiting time ", " setting time " and " operation time ". " Waiting time " is a function of flow type, of load, of batch quantity and frequency and of production method. " Setting time " is mainly a function of plant and tooling design, but is also affected by loading sequence and batch quantity. " Operation time " is a function of method, operating efficiency and batch quantity. Batch throughput time — the sum of these highly variable components — has a certain fixed element which does not vary with batch quantity, but the total value tends to fall with each improvement in flow and with each reduction in batch quantity.

Consumption time on the other hand is mainly a function of demand.

5. output and capacity

The output at any point in a flow stream can be represented as a series of pulses indicating the completion of batches in relation to time. The length of the pulses can be made proportional to the values of the batches. The output can also be represented by a curve showing the total value of all the pulses occurring in successive periods of time. The type of cycle achieved is again a function of batch quantity, frequency and phase.

Output is limited partly by capacity and partly by demand. Capacity is a measure of the maximum output which can be achieved. It is limited by the amounts of material, labour, plant and capital available, by the balance between these factors, by methods, and by the efficiency with which they are used. In practice, due to the interdependence of different parts of the system, capacity at any given moment is usually limited by one bottleneck or restriction, which limits throughput at one particular point in the flow stream.

Fig. 14 now illustrates the effects on output of the capacity limit and of variations in demand. Only a part of the potential capacity of labour, plant and capital is profitably used under present conditions.

6. demand

Demand can again be represented by a series of pulses representing orders received, or again by a curve representing the total values of these orders in a series of given time intervals.

Demand at the final or consumer end of the flow stream can be affected by many factors such as the weather, the seasons, special holidays and so on. This type of variation can be called the " natural demand variation ".

If the natural demand is predictable and can be forecast, it should be possible to meet it, as shown in Fig. 15, by matching the demand variation with an equivalent output variation; by keeping output steady and using stock to absorb the demand variation; or by a compromise in which part of the

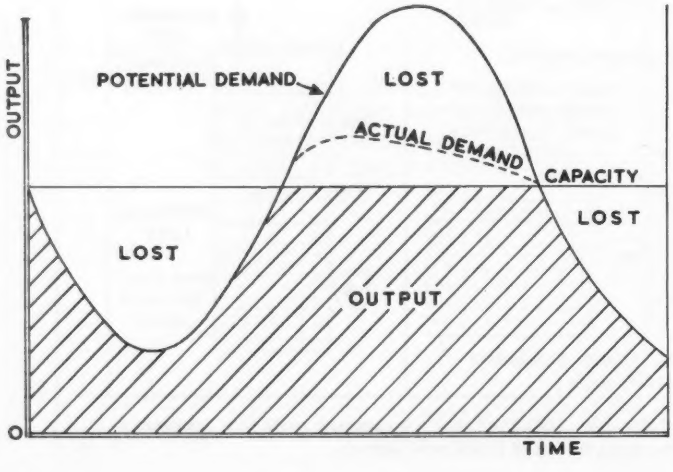


Fig. 14. Reduction in output due to capacity limit and the demand cycle

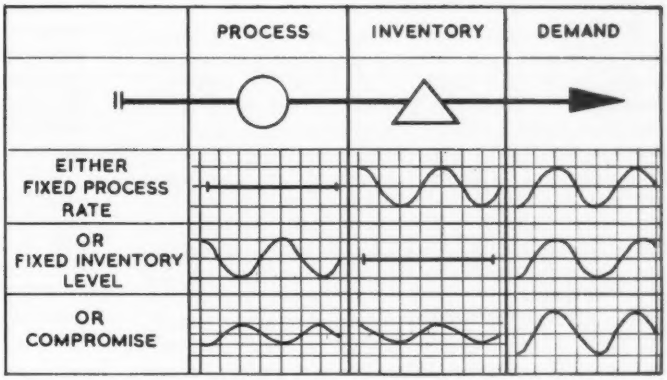


Fig. 15. Alternative ways of meeting a fluctuating demand cycle

demand variation is absorbed by stock and part by output variation. In other words it should be possible to work with a lower manufacturing output variation than the natural demand variation, and gain the advantages of maximum use of capacity and an even level of employment.

In practice this condition is very seldom achieved. The typical condition is one in which the natural demand variation is considerably magnified by the time it reaches the manufacturing unit. It is submitted that this magnification is mainly due to the wide use of "stock control" and to the low processing batch frequencies and low demand order frequencies, used with that system of ordering.

Most production flow today is controlled by "stock control". The material flow streams are broken into segments by inventories both at company boundaries and very often inside individual companies. Orders are released according to the stock level at each inventory. This type of system always magnifies the demand variation, so that a $\pm 5\%$ natural variation in demand amplitude, after transmission through three inventories (say retailer, distributor and factory stock) can easily be increased into $\pm 40\%$ variation in the demand on the manufacturing unit. The effect is known from frequent observation, and research on "Industrial Dynamics" at the Massachussets Institute of Technology has shown that it is the natural behaviour of this type of system.

It is submitted that the reasons for this magnification are as illustrated in Fig. 16. The demand cycle transmitted by each unit tends to vary inversely with its stock cycle. The natural stock variation in each unit is increased by the demand variation it receives (see Fig. 9). Each unit tends, therefore, to transmit a higher demand variation than it receives.

The condition for minimum magnification of the demand cycle is one in which both processing batch frequency and demand order frequency are at a maximum in all units in the flow stream.

Magnification must be significant with a stock control system, because such systems have multi-phase flow, and can only be operated at low batch frequency. At high batch frequency, the batch "lead time" tends to exceed the "throughput time" making it impossible to set an "order point" or "re-order level". Stock control systems, therefore, induce the conditions which give maximum magnification of the natural demand cycle.

It should be noted that the demand and stock cycles in industry are never as regular as those shown in Figs. 15 and 16, and the demand cycles never mirror the stock cycles in relation either to shape or time, in the precise manner illustrated. These diagrams merely illustrate the mechanism of change.

7. *the trade cycle*

It has been demonstrated that the cylindrical changes in demand at company level are a function of the natural demand cycle, of the type of ordering system, and of the batch quantity, frequency and phase used in both processing and ordering. It is a logical extension of the same principles, to say that the probable cause of national and world trade cycles is the cylindrical nature of the demand curves in the component flow streams.

Because the cycles of demand generated by most companies today have high amplitude and differ in frequency and phase, it is inevitable that there will be national and world trade cycles, and that there cannot help but be occasions when the peaks or troughs of the component cycles drift into phase causing "boom" or "slump".

Although there are many other factors which affect the trade cycles, they only modify the inevitable cycles produced by low batch frequency flow. It is submitted that *the amplitude of the trade cycle could be substantially reduced if we reduced the amplitude of the demand cycles at company level, by increasing the processing batch frequencies and demand order frequencies used in production.*

It is not surprising that present efforts to control the trade cycle by changes in monetary policy and taxation are unsuccessful. This is inevitable because, apart from a tendency to increase the amplitude of the natural demand variation, such methods are mainly directed at treatment of the symptoms and leave the disease untreated.

8. predictability and flexibility

It should be noted that the predictability of future demand is a function of the characteristics of demand variation. In the limit, if there is no variation, demand is completely predictable. If there is a variation but it is completely regular following some fixed natural cycle such as the seasons of the year, then again it is comparatively simple to predict future demand. Under present conditions most production units must always suffer an erratic variation in demand and the accuracy of forecasting or prediction depends mainly on the time ahead which has to be covered.

The " flexibility " of a material flow system, or its ability to follow demand fluctuation, again depends on the batch quantity, frequency and phase. Fig. 17 shows, for example, that if the batch frequency is two batches per annum, the company must have an average notice of seven months of any change in demand, if they are to change the production programme without losses due to obsolescence or increased capital tie-up. An increase in batch frequency to 12 batches per annum reduces this period of notice to an average of one month.

In industry today, we expect miracles of detailed prediction from our Sales Managers. These are both impossible and unnecessary. Companies which operate at high batch frequency require only short-term " firm " programmes, and can change plans quickly without obsolescence and without large changes in capital tie-up. In the limit, with line production, and with simple products with short lead times, it is often possible to reduce the firm programme to one or two days, and to load only firm sales orders on production. The crystal ball can then be thrown away.

the present approach

It has now been demonstrated that the adoption of single-phase, high batch frequency line flow can reduce stock and capital tie-up; release factory floor area; reduce data processing; reduce total cost;

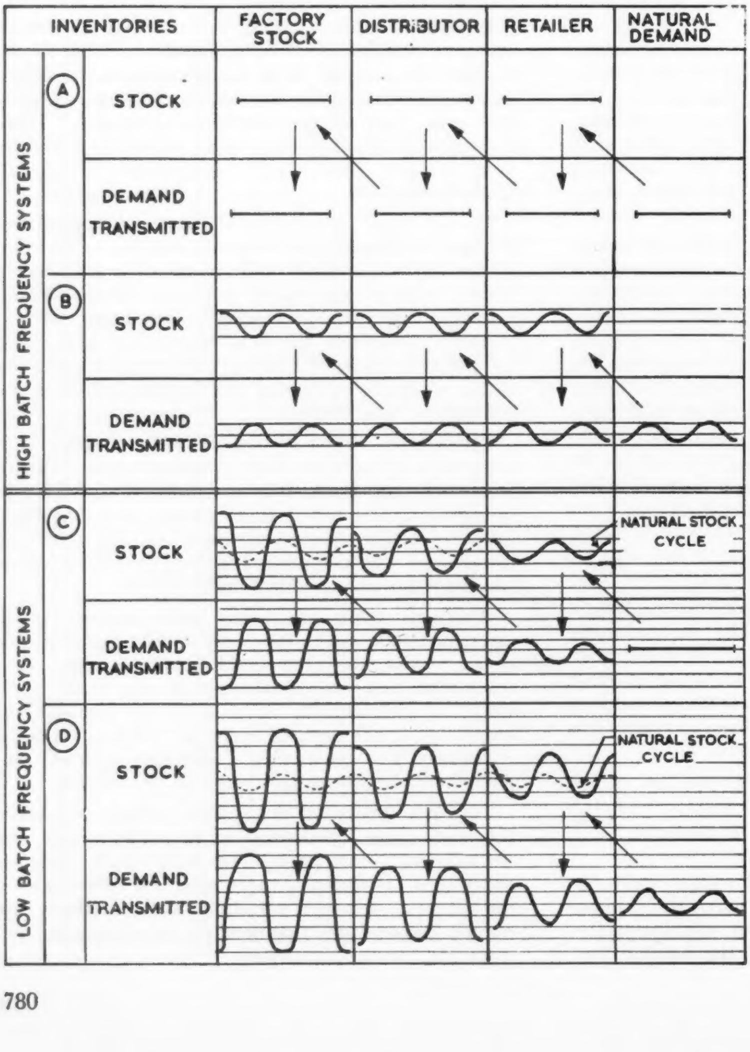


Fig. 16.

THE MAGNIFICATION OF THE DEMAND CYCLE

In cases A and B there is low normal stock variation because flow is at high batch frequency. In cases C and D there is a significant natural stock variation due to low batch frequency flow. The normal stock variation is amplified by the demand variation it receives. The demand cycle transmitted varies inversely with the stock cycle. Note in C: an even rate natural demand can produce a variable demand after transmission.

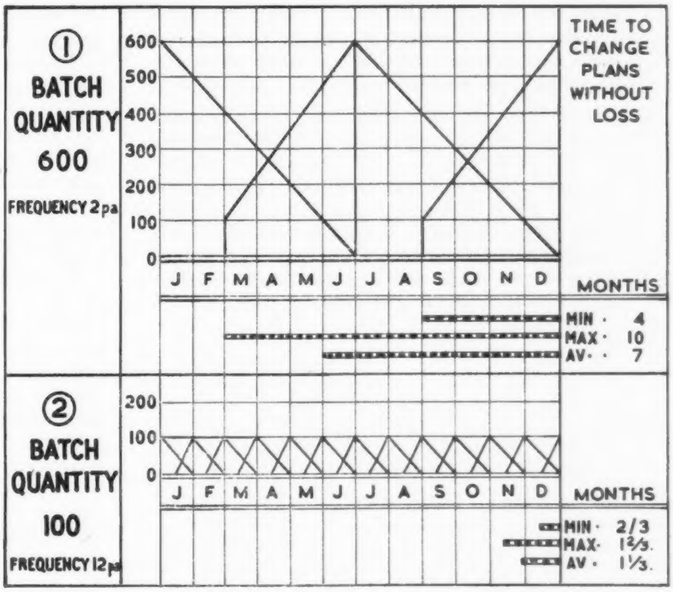


Fig. 17. Effect of batch quantity on flexibility.

simplify and increase the flexibility of control; and, finally, by smoothing the demand variation, can increase effective capacity and output.

The most striking characteristics of production today are high capital tie-up, highly variable demand cycles, low batch frequency material flow, and paper-ridden, bureaucratic inflexible controls. It remains to consider why the obvious solution of line production is so seldom used outside the limited field of mass production.

The reasons can be found in certain deep-seated beliefs, which form part of our present philosophy of management. Here five of these beliefs will be briefly considered.

1. the belief that a reduction in direct labour cost reduces overheads in proportion to the allocation rate

This is a belief never held by the trained accountant, but still fairly widely held in other branches of management.

Consider a company which uses an allocation rate of 200% on direct labour to absorb its overheads and find Total Costs. Assume that a particular job has a material cost of 15s. 0d., a labour cost of 10s. 0d., overheads of £1 (200% of 10s. 0d.), and a total cost, therefore, of £2 5s. 0d. If the labour cost is now reduced to 5s. 0d., the new total cost will be £1 0s. 0d., with an apparent saving of 15s. 0d. The actual saving, providing there is no change in output, will be little more than 5s. 0d.

The reason is obvious. The apparent saving of 15s. 0d. merely exploits the approximations used for convenience in costing. There is very little real change in overheads directly induced by a change in direct labour cost.

The importance of this belief is that it misdirects nearly all the effort for cost reduction in industry towards direct labour cost, and seems to imply that it is unnecessary to worry about overheads because they will fall automatically if direct costs are reduced. It also precludes the consideration of changes which increase direct costs, but reduce Total Cost due to their effect on overheads.

2. the belief in stock control

This belief holds that a satisfactory material flow can be generated by dividing a given flow stream into segments separated by inventories. Flow is then maintained by releasing orders on the basis of a re-order rule founded on stock levels.

As explained earlier, this type of system inevitably exaggerates the demand variation, so that a small demand variation at the final outlet will quite commonly be multiplied eight times or more after the third or fourth inventory. The system has the serious deficiency that it can only be operated with large batch quantities and small batch frequencies, thus reducing flexibility and further inflating the cyclical variation.

3. belief in the so-called economic batch quantity theorem

This theorem holds that there is a large and significant variation of cost with changes in batch quantity, and that for each component produced there is one special batch quantity which will give minimum cost. The case against this theorem has been developed at length in previous Papers; the following summary gives eight of the reasons why it is false :

1. By imposing different batch quantities for different components, it itself imposes multi-phase flow, with its associated high costs of obsolescence, storage and administration. A substantial reduction in costs can be made by

changing to single-phase flow. Batch quantity analysis can only find minimum cost in the inefficient system imposed by itself. It can't find minimum possible cost.

2. The belief that cost varies substantially with batch quantity change can easily be disproved by detailed analysis of company trading accounts. Such analysis normally produces a comparatively flat curve over most of the possible range of batch quantities. If the total change is insignificant, there must be something wrong with the deduced mathematical models, which show a significant variation for components.
3. The economic batch quantity always gives a sub-optimum return on the capital investment. Due to the shape of the curve, it must be possible to find a batch quantity lower than the E.B.Q., which will give a higher return on the investment. By the same reasoning, if the economic (*sic*) batch quantity is used throughout, a large part of the stock must represent an investment at a low marginal rate of return, which could easily be bettered by re-investment.
4. It represents a ridiculous and improvident investment policy. It fixes the amount of capital to be invested in stock by a very large number of separate calculations, which produce a chance total without any reference to the actual amount of capital available.
5. Many of the factors which have to be used in the "models", cannot be measured economically or are intangibles with no exact meaning which have to be guessed (e.g., storage cost per piece, and opportunity cost).
6. It treats method as a constant; it measures, for example, the cost of setting-up and uses this value as a constant in the model. It ignores the — in practice — much more profitable possibility, that an investment in method and tool development instead of in stock could reduce setting-up cost and overheads generally.
7. In large scale high volume production (both manufacture and distribution), line flow and maximisation of the rate of stock turnover are accepted and successful strategies. In low volume mixed production, the strategy of batch quantity analysis at present holds favour. In a system with such an obvious unity as production, it is unlikely that two diametrically opposite philosophies can both be right.
8. In the extremely complicated system of interrelated variables which is production, it is unlikely that any simple solvable mathematical equation, created by deduction from basic premises, can form a "model" which is isomorphous with the system. Even the most complicated expression can only hope to give a rough approximation of the relationships at one moment in time, and to have the most transient of values.

4. belief in control by a number of independent specialists

In most of production today the control function is divided among a number of independent specialists, with a traditional division among them of the responsibility for parameter changes. Generally, the specialists alter these parameter values with a view only to their own special areas of control. Because any parameter change tends to affect all the output variables, such an arrangement only complicates the system and reduces its stability.

A simile might be a car, so designed that one man operated the steering wheel, another the accelerator, another the clutch, another the gear lever, and so on.

Success in control depends on choosing a combination of parameter values which will influence all or most of the output variables to change in the required direction. Integration is essential for efficient control, as every parameter change must be considered in relation to its effect on all output variables. The present system not only reduces stability; it also tends to duplicate records and other administrative paperwork, and it thus seriously inflates overheads.

5. belief that line layout cannot be used for low outputs

It is generally believed that "line layout" is only possible for mass production. This is a type of rotating fallacy which often occurs in highly departmentalised bureaucratic organisations.

The production engineer knows that line layout is almost always technically feasible, but believes that there is an economic bar—the economic batch quantity theorem—to its use at low output rates. The non-technical, financial manager probably knows that the economic limitations are extremely suspect, but believes that there is some technological limitation to the use of line layout.

Between the two of them it is seldom even considered.

the new approach

1. the aims and general approach

The primary aims of the New Approach are: to reduce stocks and thus release capital and floor space for more profitable use; to simplify administration and control, thus reducing cost and releasing indirect labour for more productive and creative work; and to increase effective capacity and output, by reducing the amplitude of the demand cycle.

The principal methods advocated in order to attain these aims are: first, the creation of line flow systems; second, the use in these systems of high batch frequency single-phase material flow; third, the substitution of high demand frequency flow control for stock control; and, fourth, the simplification of administration and control procedures.

2. creating the line flow system

Consider, as an example, the complicated and difficult case of a general engineering works making a wide range of engineering products in small volume, by such processes as forging, casting, machining, press work and assembly.

It is possible to classify all the components made in such a factory into "families", so that all the components in each family are made by similar operations, in the same sequence, on the same plant. Classification can be greatly simplified by: reducing material and component variety (simplification); by some redesign to make awkward components fit the classification; by adjusting existing process layouts to obtain standard process sequence; and by adjusting the make-or-buy distribution, to lose awkward components and bring back bought items which will fit into "families".

This process does not represent an attempt to force a square peg into a round hole. It merely reflects the natural order of things. Components normally do fall roughly into "families" which can be processed by the same items of plant, and the sequence of operations does normally follow roughly the same pattern for all items in a family.

3. plant layout

For line flow, the plant must be laid out in the sequence dictated by the standard process layout for each "family".

One of the problems is to achieve an approximate balance between the capacity supplied for each operation. This can be achieved by way of the tested methods already in use in mass production; by, for example, supplying more machines for long operations than for short ones; by doubling the lines so that one operator can do two or three of the short operations; or by changing methods and re-designing tooling to eliminate bottlenecks.

An excuse often made for not using line flow with low volume output, is that it is very difficult to obtain an exact balance of plant capacity. This is true. It is also true, however, that such a balance is even more impossible with functional flow. The capacity of the line flow system in practice, is generally higher than that of the equivalent functional flow system.

Lack of potential output balance is always accepted on automation lines. Actual balance is only obtained by de-rating most of the machines in the line. For some reason the same solution is seldom accepted for manned lines, although it is generally possible to obtain approximate labour balance. It is generally forgotten that de-rating can itself pay dividends—for example, improved quality, and reduced maintenance.

4. tooling

Each machine must now be equipped with jigs and tools, so that all the components in the family can be processed. Because all the components in each family are similar in form, it is usually possible to design adjustable tooling which can be used for a number of different items. For this reason the amount of tooling and the tooling cost are generally less with the line flow system, than with normal batch production and a functional layout.

5. setting-up

It will be realised that if the machines in these lines can be reset in a matter of seconds, rather than in hours and minutes as at present, there is nothing to prevent their use at high batch frequency. If setting time is short enough, there is no reason why the lines should not be reset 20 or 30 times a day for different components. The lines can even be scheduled to make "today", the parts required for "tomorrow's" assembly, and be reset again the next day to make the following day's exact assembly requirement of the same parts.

It is surprisingly easy to reduce setting times. The problem is one which has received little attention. Because the engineering industry normally uses large batch quantities and setting-up cost is therefore only a small part of cost per piece, it has not seemed worth the effort to reduce it. If the effort is made, setting-up time can generally be decimated at comparatively small cost.

The leading authority in this field is an Italian engineer, Signor Patrignani, who has achieved spectacular reductions in the setting times for machining and sheet metal working processes. As an example, it is possible with his equipment to change the set-up on a 90-ton power press in 15 seconds, compared with the 30 - 40 minutes common in the industry. It is no criticism of Signor Patrignani to say that his solution is very simple. He has merely designed a simple method for the rapid and automatic location of die-sets on presses. His real genius lies in his recognition of the problem. Once the need is realised, the solution is generally a comparatively simple exercise in tool design.

6. a practical case

The instance of a general engineering works making a wide variety of products in small volume was chosen because it is one which is already being successfully applied.

A French manufacturer of special switchgear for the electrical industry—Messrs. Alsthom-Lecourbe, Paris—have converted part of their plant to this system, using a similar approach to that described above. The results achieved have included a very big reduction in stock, three to four times the output from the same floor area, a reduction in lead time for new orders from three months to three weeks, a 45% reduction in throughput time per order, and reduced tooling costs.

An additional and unexpected advantage was an improvement in morale. In a Paper delivered to the Xe Congres Internationale d'Organisation Scientifique, Paris, 1957, M. Mongon — a director of the Company — attributed this improvement to the operator's closer association with products, rather than with isolated operations.

It will be obvious that this type of manufacturing represents one of the most difficult cases which could have been chosen for the introduction of line production. The fact that it is possible makes it likely that even better results could be obtained in other less complex industries.

7. automation

The limit to the use of automation is the feasibility of line production. If small quantity mixed product output can be handled by line production, then auto-

mation must eventually be possible in the same industry.

Examples can be found even today. For example, a multi-spindle vertical chucking automatic, tooled so that it can machine a number of similar collars and flanges, is really an automation line, designed to handle a particular " family " of parts.

There is no real reason why automation should not be used for low volume products. There is no real reason why the world cannot have both product diversity and low cost.

8. data processing

The change to line flow must inevitably cause an important reduction in the complication and cost of data processing.

Most of the complication in our present systems is a direct result of low batch frequency multi-phase flow. The present complicated systems of individual incentive payment, component standard costing, budgetary control, component batch scheduling in production control, and the rest, are mainly the products of complicated flow. Much simpler and cheaper systems can be used to control line production.

The simplification of data processing will facilitate the application of computers and hasten the integration and automation of data processing.

With the wider use of line production, it should be possible to release a large proportion of the labour force now engaged on data processing for more creative and productive work.

9. the demand cycle

The introduction of line production inside individual production units will itself tend to smooth the demand cycles in industry. To obtain the full possible benefit, however, it is essential that high frequency material flow should be matched by high frequency demand, or order flow.

The final demand at consumer level is generally a high frequency demand, calling for single items rather than batches. Any reduction in this frequency of order issue, by accumulation into large batches, tends to multiply the demand variation.

The ideal system for minimum demand variation would be one in which each sale to a customer caused an equivalent order to be issued to all production units in the flow system. Under these conditions the natural demand variation is repeated in all units. If the mean natural demand can be forecast, it is possible to use stock to absorb all or part of this variation. For example, in a manufacturer/distributor/retailer flow system, the manufacturer could produce at the mean rate required to meet the demand, and the natural variation could be absorbed by changes in factory, distributor and retailers stocks. This approach is impractical with the present low batch frequency flow because the demand cycle has both high amplitude and low frequency (often several years). Enormous stocks would be needed to absorb the variation, and in these long periods, most of it would be lost due to obsolescence.

The organisation of flow control systems of this type would be comparatively simple inside the vertically organised industry. It would call for co-operative effort in many industries where the organisation is horizontal.

10. the application of the new approach

The final solution of " line production " has been described. The New Approach is not, however, a one-step philosophy. Many of its advantages can be obtained very quickly by a progressive application of the principles. For example, the progressive completion of the following programme might well make the whole programme self-financing, the changes being financed from the progressive reduction in capital tie-up :

1. reduce batch quantities immediately to the limit which can be controlled with existing systems;
2. classify the components into " families ";
3. analyse the components by output value and select the 8% to 12% of components which represent the majority of the total output value (in engineering 12% of the components will often account for 75% or more of the total output value);
4. segregate the plant for the " families " which contain the majority of the high output value components into groups (group layout);
5. adopt a simple single-phase ordering system (Period Batch or Standard Batch control) for these groups, and increase purchasing and processing batch frequency to a minimum of 12 or 13 batches per annum.
6. study the process sequence in each group, study the setting problem, and design one or more " lines " to handle all the components in each family by line production;
7. repeat the process for the remaining " families ", of lower output value;
8. take the savings possible by eliminating the production flow stores previously required due to multi-phase flow;
9. Simplify data processing and integrate control. Eliminate the costly complicated systems necessary to control low batch frequency, multi-phase flow. Substitute the simpler integrated low cost systems appropriate to line production;
10. tackle the demand problem, adopting flow control systems in place of Stock Control;
11. tackle the supply problem, persuading suppliers to give high batch frequency supply;
12. adopt automation both for material processing and for data processing with the computer.

conclusion

Our present methods of controlling material flow result in an enormous waste of capital, indirect labour, and production floor area. Only a small

(*concluded on page* 793)

BUTT WELDING IN THE TOOL INDUSTRY

by R. H. HIND, A.M.I.Prod.E.

Development Engineer.

Tool Division,

Arthur Balfour & Co., Ltd.

Mr. Hind received his technical education as a part-time student at Rotherham Techhical College. After serving a general engineering apprenticeship at Newton Chambers & Co., Ltd., he entered the Jig and Tool Drawing Office of the Excavator Division. In 1953, he joined the Domestic Appliance Division of The General Electric Co., Ltd., as a Designer Draughtsman.

Mr. Hind joined Arthur Balfour & Co., Ltd., in 1957, and in 1960 was appointed Development Engineer for the Company's Tool Division.

THE first joints to be made by a welding process were carried out by the blacksmith in his forge. The ends of the two pieces of metal to be joined were placed in a hearth or brazier in direct contact with the fuel, and the necessary heat was obtained by operating some type of bellows to blow the air through the fuel. When the welding temperature (which is higher than the forging temperature) was reached, the blacksmith placed the heated ends in an overlapping position on his anvil and hammered them together until a joint was formed. The hammering necessary to form the weld was beneficial to the structure of the material as it helped to reduce grain size, and therefore improved its mechanical properties, but it often happened that particles of scale formed during the heating were trapped in the weld, leaving it much below the strength of the parent metal.

This type of welding is occasionally used today, but it is very limited in its application, slow, and far from satisfactory.

The resistance welding of metals came with the introduction of electrical power to industry. The original patents were taken out by Professor Thompson in the late 19th century but it was a long time before it was developed for industrial use. The theory of the method is that an imperfect joint such as

the abutting ends of two pieces of metal which offers a great resistance to the passage of current will naturally heat up. Thus, by passing a very powerful current through the joint, welding temperature can be quickly reached and if the two ends are then forced together a weld is formed.

For this type of welding a single phase alternating current is used. This is fed through a transformer to an output voltage of around 4 to 6 volts.

butt welding

The two parts to be welded are clamped in position with the ends which have been squared touching one another. If the two pieces are of the same material the joint will be in the middle of the gap between clamping electrodes but, if different materials are to be joined, the piece with the least electrical resistance will protrude furthest from the clamps. This will balance the resistance and therefore give more even heating.

When welding small sections by this method, the pressure is applied axially to the joint before the current is turned on. Thus when the ends are heated and become ductile, the pressure is able to overcome the strength of the material, and the two pieces are forged together.

On larger components it is usual to commence the weld with a somewhat lower pressure so that the heat may be localised as much as possible at the joint, a handwheel or lever being used to keep the ends in firm contact until the welding temperature has been reached. A high pressure is then applied either manually or by a hydraulic or pneumatic ram.

flash butt welding

For many years this type of butt welding was the only process known, but it was realised that its usefulness was restricted and that it could not be employed satisfactorily on sections which were thin in comparison with their area, due to the spread back of heat causing softening and bending under the application of pressure. Also, the amount of current used on larger sections could make the operation very uneconomical.

In the early 1920's, to overcome these difficulties, flash butt welding was developed. In flash butt welding the two components to be welded are again gripped in electrode clamps, but instead of forcing the ends together and simply passing a current through them, the two ends are only lightly brought together. This causes arcing to take place, and providing the current and resistance are adequate the temperature of the material at the contacting faces can be raised to melting point in seconds and kept very localised.

In order to continue the build-up of heat locally on either side of the weld line, the electrode clamp holding one of the components is mounted on a machine slide. Thus as the metal on the joining faces is being burnt away, the arc can be maintained by moving one piece towards the other at a suitable speed. This flashing action is allowed to continue until the area immediately behind the faces has reached welding temperature. When this condition has been obtained the two pieces are forced together with a high mechanical pressure (which is usually exerted through the moving jaw) and at the same instant the electrical power is cut off.

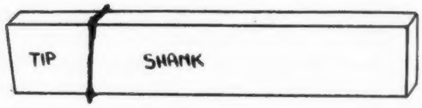


Fig. 1. Welded turning tool blank

high speed steel cutting tools

One of the many applications of flash butt welding is the joining of high speed steel to a tough ductile steel as used in the manufacture of cutting tools, such as drills, reamers, end mills, lathe, planer and shaper tools. This type of tool requires an extremely strong and wear-resisting cutting edge to withstand the forces and high temperatures encountered in machining, together with a tough ductile shank for strength. This composition is therefore used both for economy and utility (see Fig. 1).

welding machines

There are many flash butt welding machines on the market, ranging from manually operated to fully automatic types. The small manually operated machine, as illustrated in Fig. 2, is used for welding a variety of small tools. The right-hand clamp is mounted on a sliding cast-iron saddle operated through a crank and toggle link by a hand lever. This arrangement gives a high mechanical advantage when forcing the two pieces together and provides easy control for flashing. Vertical and horizontal adjustment of the left-hand jaw helps to facilitate the correct alignment of the workpieces after clamping has been effected.

The clamps are operated by capstan wheels and any tendency of the workpieces to slip during butting is prevented by adjustable stops. The electrode jaws and clamps can quickly be changed when worn and are prevented from overheating by a water circulation system. The electrical power is supplied by a 40 kVA air-cooled transformer, with tappings provided to give the requisite amount of current to cover the range of sections that the machine is designed to weld. A tap changer is connected to the primary windings of the transformer to give a range of eight different secondary voltages, between 3 and 6 volts.

The flash butt welding process lends itself to a certain amount of automatic control and during the past few years a lot of development work has gone into the production of semi-automatic and fully

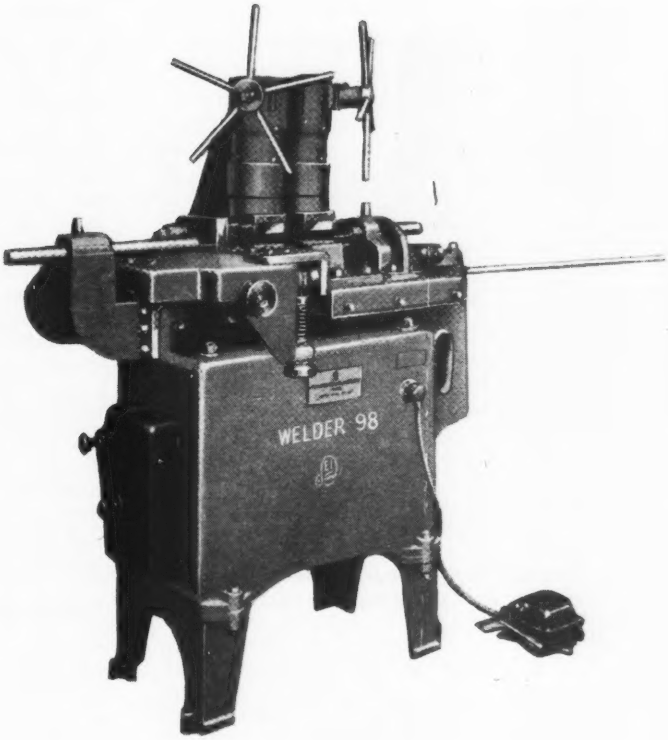


Fig. 2. Tool flash butt welding machine, manually operated (B.I.C.C. Ltd.)

automatic machines. There are now many different types of automatic machines on the market, used for mass or large batch production. Automatic machines for welding a particular size of component can be successfully operated by means of a profiled cam driven by an electrically geared motor making one revolution per weld. The speed of the cam's rotation is controlled by a variable speed unit, and is arranged to give an initial slow approach, with a gradual acceleration towards the end of the flashing period. A sudden rise in the cam profile then causes the moving jaw to butt, completing the weld.

For larger work and over a range of sizes clamping, flashing and butting can be automatically operated by either pneumatics, hydraulics, air hydraulic intensifiers or a combination of these (see Fig. 3). Setting this type of machine consists of adjusting a series of cams, scales, and valves. All the operator is required to do is to place a component in each electrode and press the weld control button.

Between the fully automatic and the manually operated machines are the semi-automatics (see Fig. 4), where the operator still has control over the speed of flashing and amount of material burnt off, but the final upset pressure is operated automatically, so making the effort of welding much less strenuous. On all three types of machines, the operator usually works from a chart to set the variables on the machine. The manually operated machine chart will contain the tool sizes, what tapping to select, the jaw

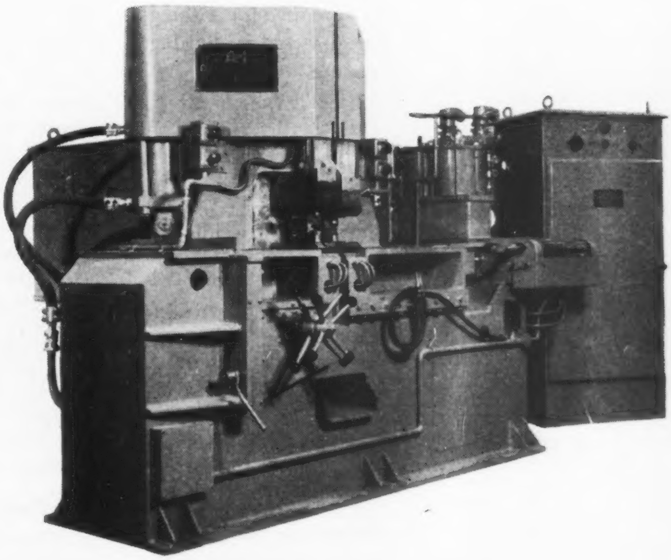


Fig. 3. Fully automatic drill and tool flash butt welding machine (A. I. Electric Welding Machines, Ltd.)

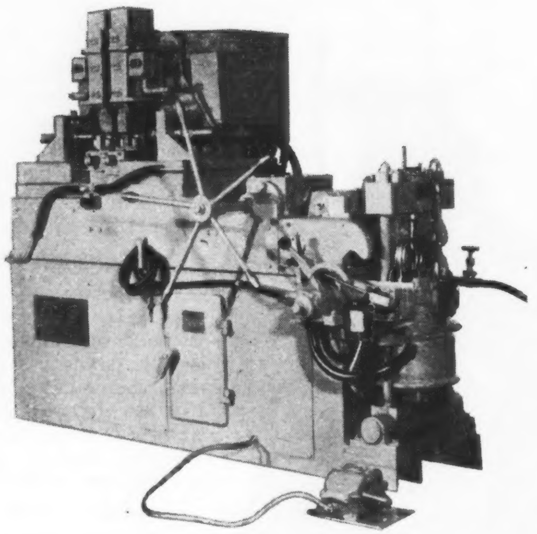


Fig. 4. Semi-automatic flash butt welding machine (A. I. Electric Welding Machines, Ltd.)

gap and how much material to be burned off, but with the automatic welding machine the chart for setting could list the following data :

Size of tool.	When current is cut off.
Type of electrode.	Acceleration of moving jaw.
Electrode gap.	Flashing time.
Gap between components.	Number of pre-heats.
Amount of protrusion of respective parts.	Duration of pre-heats.
Transformer tapping.	Pressure used for flashing.
Length of stroke.	Pressure used for butting.
Amount of butt.	Pressure used for clamping.

electrical power

Flash butt welding is one of a group of welding processes which come under the heading of resistance welding. This means that the heat for welding is produced by the resistance of the components and the amount of current passed through them. This can be calculated from :—

$$H = \frac{I^2Rt}{J}$$

Where H = *heat produced (B.Th.U.s)*
J = *Constant, Joules Equivalent (B.Th.U. value).*
I = *current in amps.*
R = *electrical resistance in ohms.*
t = *duration of current flow in seconds.*

Therefore, the heat produced is not only directly proportional to the resistance of the components and to the time of current flow, but it is proportional to the square of the current value. For reasons of economy in time, the value of the current available for welding is many times greater than the current taken from the mains. These high welding currents are obtained by means of a single phase transformer, the primary windings of which consist of many turns. The secondary windings, however, usually consist only of single turns and are often water-cooled to prevent overheating. In this way the mains voltage is stepped down to as low as 3 to 12 volts at the electrodes, giving a secondary current when welding of possibly 20,000 to 30,000 amps.

There are generally about 6 to 14 different tappings on the primary side of a butt welding machine. These are connected by bridging across the connections with a tap changer. It is usual for half the tappings to be connected in parallel and the other half in series, giving a difference in secondary voltage between two tappings of about .3 to .6. The following are the secondary voltages available on the machine shown in Fig. 3.

voltage available at electrodes

Plugs or Tappings	*Connected in parallel Volts*	*Connected in series Volts*
1	11.5	5.8
2	10.6	5.5
3	9.7	5.2
4	8.7	4.9
5	7.9	4.6
6	6.8	4.3
7	6.0	4.0

transformers

The number of turns of the primary and secondary windings of a welding transformer are calculated to ensure that the no-load current and the flux (lines of force) in the core are not excessive. The busbars or tails from the transformer to the electrodes should be as short as possible to prevent power losses, and a water cooling system is usually employed on the large transformers to prevent overheating and thus inefficiency. Air cooling is usually sufficient on transformers up to 40 kVA.

Resistance welding transformers differ somewhat from ordinary power transformers since the loading is intermittent. They are usually rated on a duty cycle of 4 to 6%. This is the percentage time that the demand exists and is calculated by taking the "time on" divided by the "time on, plus time off", multiplied by 100. A welding transformer can therefore stand a very high overload for a short period.

Power factor correction is necessary to even out the fluctuations in current due to this intermittent loading (see Fig. 5).

the flashing action

When the two components to be welded are lightly touched together, an electric circuit is completed

between the faces in contact. The power of this current is dependent upon the tapping selected (secondary voltage), the electrical resistance of the material, the cross-sectional area and the force applied to the contact. Provided the voltage and component resistance is adequate, the temperature at the contacting faces can be raised to welding temperature in seconds. The small irregularities on each welding surface make the first contact. These offer a resistance to the current which generates heat and quickly melts them, forming points of molten metal through which the current tries to pass. This results in small explosions which expel these molten particles leaving a minute gap between the faces. Small areas left after the initial explosion will have a temperature close to melting point causing further explosions and as the two components are moved together at a suitable acceleration, this action becomes continuous, with hundreds of flashes occurring every second.

The speed of flashing is very critical and the operator on a manual machine needs experience to judge this. Too rapid or too slow a movement of the saddle at this stage will cause the flashing to cease part-way through the stroke. The former will bring the ends into intimate contact too soon and the latter will cause them to separate, allowing the heat to die away. In both cases, if flashing is restarted immediately, the ill-effect should be negligible. On automatic machines this fall-away of heat will cause the pre-heating cycle to operate until sufficient heat is built up to allow flashing to continue. A drop in mains voltage at this stage can have similar results.

Flashing is continued until the whole of the faces to be welded have reached a sufficient temperature to enable a joint to be made. At this temperature the faces will have almost reached melting point with a depth of plastic material behind them. The distance the moving jaw has to travel to build up the necessary heat is preset to the minimum required. By making and breaking the contact between the components once or twice before flashing begins, this distance can be reduced still further. This is called pre-heating.

pre-heating

It is usual when welding all but very small tools to pre-heat. This consists of bringing the components together as for flashing, but as soon as flashing commences, they are short circuited and withdrawn again, thus breaking the contact. This is repeated several times, depending upon the cross-sectional area of the components. There is very little expulsion of metal during pre-heating, but the ends of the components are quickly brought up to a temperature which enables continuous flashing to proceed without the use of a high current. By pre-heating, fairly large sections can be flash welded on a machine which has only a relatively small transformer, and therefore has not the power to flash them from cold. As the heat is built up with very little loss of metal, the length of flashing necessary, and thus the amount of material burnt off, is reduced. This means a big saving when welding high speed steel.

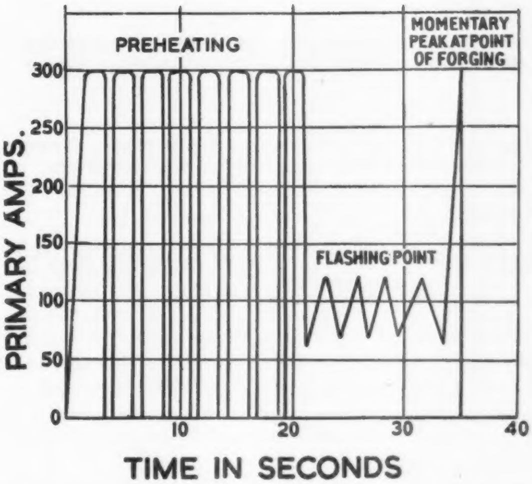


Fig. 5. Current loading when welding 2 in. dia. drill blank

A lower resistance is offered by the two components during pre-heating. This causes a subsequent rapid increase in current, producing the high temperature required, but when flashing commences the resistance is increased. This is due to the partly molten metal which is making only a poor contact and to the rise in temperature which causes an increase in electrical resistance.

This is equal to:

$$R_2 = R_1 \frac{(1+Kt_2)}{(1+Kt_1)}$$

Where R_2 = *the resistance of the conductor at t_2°C.*

R_1 = *the resistance of the conductor at normal air temperature.*

K = *the temperature coefficient of the conductors.*

t_2 = *the temperature of the conductor at which the resistance is required.*

t_1 = *normal air temperature.*

This increase in resistance during flashing is seen by the drop in current (Fig. 5), which shows the current loading when pre-heating and flashing a 2 in. dia. drill blank. The final rise in current as butting takes place is due to the low resistance prevailing when the two pieces are forced together and the molten particles squeezed out, resulting in a good contact.

Pre-heating is often advantageous when welding tools, because gradual rather than sharp changes of structure are required to reduce the stresses and minimise cracking. If care is taken during welding to produce a good weld without undue stresses, the amount of post-heat treatment needed can be kept to a minimum.

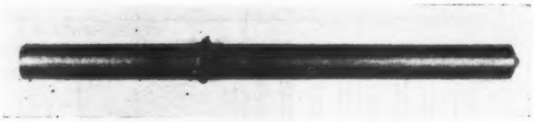


Fig. 6. Flash butt welded twist drill blank, showing ridge of ejected material round weld periphery

the butt

When sufficient material has been burnt off to allow the two ends to reach welding temperature, the final operation is forging them together. This forging action is suddenly applied as the flashing stroke is completed and coincides with the cutting off of the current. It should result in the extrusion of all molten metal and undesirable impurities as well as the upsetting of the plastic material from both components. The ejected material forms a ridge or fin round the weld periphery (see Fig. 6).

If the butting pressure is insufficient or if the welding temperature has not been reached, oxides and impurities may still remain in the weld, forming points of weakness and subsequent failure. When welding high speed steel it is usual to use a butting pressure in the order of 5,000 to 6,000 lb. per square inch.

Part-way through the squeezing together of the plastic material the electrical current is cut off. This is accomplished either by an operator-controlled foot switch or by the moving saddle operating a knock-off button or limit switch.

The current is maintained at the beginning of the butt because its presence helps to prevent the formation of oxides in the weld. These would quickly form if the current were cut off whilst a gap remained between the components. The precise moment of cutting off the current is dependent upon the amount of butt necessary and the cross-sectional area of the components. It works out approximately at half the distance moved in butting on the smaller sizes, and a third of the distance on the larger sizes. A micro-structure through the weld will show whether the butting had been correct and if the two structures have come together satisfactorily with no inclusions or porosity (see Fig. 7).

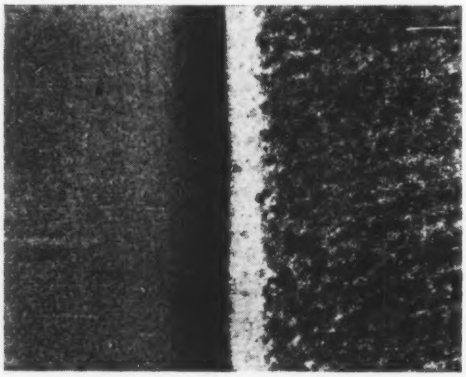


Fig. 7. Micro structure of a welded drill taken at 24 magnifications, showing the normal annealed HSS structure on the left. The central dark region is a disturbed zone caused by welding and the adjacent light coloured portion is almost pure ferrite. This zone has been decarburised due to the high temperatures reached during welding. The shank steel on the right has a ferrite and pearlite structure and the flow lines show that a certain amount of upsetting has taken place

clamping

It is important that the two components are very rigidly clamped in the electrodes before welding commences. This clamping is either operated manually (only on small machines) or by hydraulic or pneumatic means, or a combination of these. The clamping force necessary is at least twice the butting pressure, to give a good electrical contact and to ensure that the components do not slip whilst butting is taking place. Whenever possible the two components should be supported at the back by end stops (see Fig. 8), as an extra precaution to prevent slip occurring. Horizontal and vertical adjustment for aligning the components is effected after clamping has taken place.

The shape of the electrodes depends upon the shape of the tool being welded. For square tools, a flat topped electrode is usually used, whilst drill blanks and round stock are supported in vee grooves. They are manufactured from a forged copper alloy with good electrical conductivity and hard wearing qualities to stand the temperature and pressure to which they are subjected during welding. Sometimes a hard facing material such as sintered tungsten copper is brazed on to the copper electrode (see Fig. 9) so that when wear occurs, the facing can be reground a few times before being replaced. This is far less expensive than fitting new electrodes each time wear occurs.

The electrode material appears to be most efficient when its electrical conductivity is at least 50% I.A.C.S. Material with a lower electrical conductivity than this is likely to cause burn marks on the component and overheating of the jaws. A small

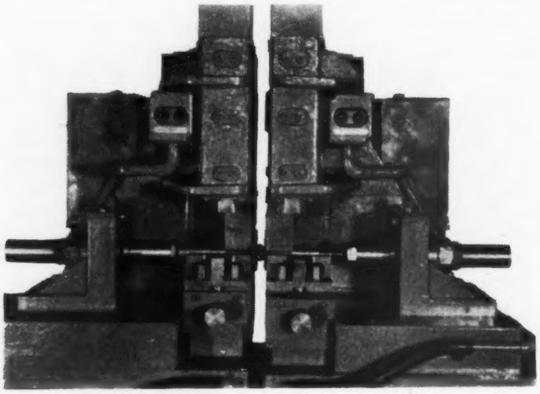


Fig. 8. Welded drill blank still retained by clamps and showing end supports

percentage of cobalt and beryllium added to copper greatly improves its wearing properties without seriously reducing its electrical conductivity, and many types of electrodes are made from this type of material.

To help in reducing jaw wear and to ensure that one clamping face of the jaws is level, it is sometimes quite satisfactory to have the bottom jaw made of a wear-resistant steel and have the current introduced through copper electrodes at the top only. The majority of wear therefore occurs at the top, leaving the bottom faces clean and flat for positioning the components. However, care must be taken in using this method to ensure that the heat is even, as it is possible to get a cold region on the steel jaw side. This can be overcome by allowing a time factor so that even heating is maintained throughout the section.

The present trend in flash butt welding machines is to have electrodes top and bottom and feed current in from both. Even heating is almost guaranteed and in many cases electrode wear reduced.

Metal expelled during welding should not be allowed to remain on the surface of the electrodes, otherwise the welding operation has to be interrupted whilst it is chipped or filed off. Air jets or other means of cleaning the jaws after the clamps are released help to overcome this difficulty.

electrical resistance of components

The resistance offered to the welding current by a component is dependent upon the amount of protrusion as well as its density. Resistance relative to the protrusion from the electrode is equal to

$$\text{Resistance} = P\frac{L}{A}$$

Where P = *the resistivity of the material in ohms.*
L = *the length of protrusion.*
A = *cross-sectional area.*

Therefore the further a component protrudes, the greater is the electrical resistance.

Incorrect protrusion of the components from the electrodes is one of the causes of burn marks and overheating. When welding two dissimilar steels such as high speed steel and low carbon steel, it is essential to give special care to this point. High speed steel, which has the higher electrical resistance, can be clamped with a minimum overhang, whereas shank steel, having a low resistance, has to protrude much further to balance the heat. Thus when welding tools, the weld line does not come in the centre of the electrodes (see Fig. 10).

This difference in protrusion bears a relationship to both the electrical and thermal conductivity. A test was carried out on a Kelvin's Bridge to measure the resistivity of the two materials. A bar of each material approximately .35 in. dia. was used and the resistance measured over a 12 in. length. This gave readings of .0011265 ohms for the carbon steel and .003055 ohms for the high speed steel. Converting back to ohms per cu. in. and using the exact

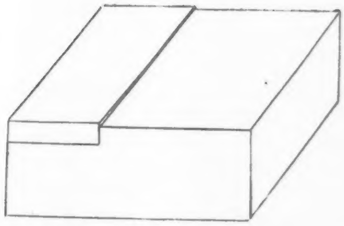


Fig. 9. Electrode for welding tools showing sintered tungsten copper insert

diameter of the bar, this works out at .00001009 ohms and .0000242 ohms, giving a ratio of 2.4 : 1.

From tables, the thermal conductivity of shank steel is approximately .11 and of high speed steel .06. This gives a ratio of 1.83 : 1 which is approaching the electrical resistance. Therefore, the high speed steel tip should protrude approximately a third of the gap between the electrodes and the shank steel two-thirds. This works out well in practice as the heat built up in each is then approximately equal.

possible causes of a bad weld

In the butt welding of high speed steel to low carbon steel, high stresses are set up in the weld. These are the results of variations in the degree of hardening and the different rates of expansion and contraction of the two materials. Also the rapid rate of cooling round the welded joint and the close proximity of the water-cooled electrodes causes a brittle and unstable structure round the weld. For this reason a stress-relieving or normalising operation is usually carried out after welding, particularly with regard to the cobalt range of high speed steels. The quickest and most effective method of carrying this out is to release the jaws of the welding machine as quickly as possible after the weld has set, and place the tool blank into a furnace situated at the side of the machine. This is kept at a constant temperature between 800 and 1,000°C., depending upon the analysis of the high speed steel. The tool blanks remain in the furnace until the heat has thoroughly permeated, after which they are allowed to cool in bins.

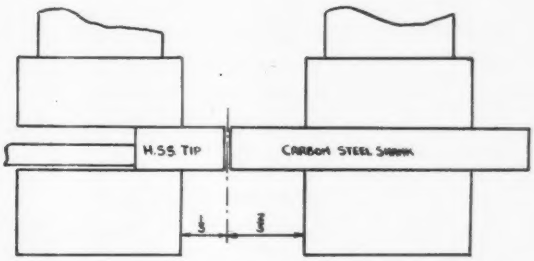


Fig. 10. Protusion of tip and shank to balance resistance

To ensure a good weld every possible precaution must be taken, as a fault could occur from any of the following causes:—

1. insufficient depth of plastic metal behind the welding faces when butting;
2. incorrect speed or distance of flashing;
3. incorrect electrode gap;
4. incorrect protrusion of parts from electrodes;
5. incomplete contact with electrodes;
6. reaching a high temperature too quickly;
7. components not lined up in the electrodes;
8. not cutting current off as butting commences;
9. not using correct pressure when butting;
10. parts not clamped sufficiently tightly;
11. allowing too much heat to spread back;
12. components not same size as weld line;
13. using incorrect tapping;
14. burning too much material away during flashing, thus leaving insufficient for upsetting;
15. too many pre-heats before flashing commences.

A faulty weld usually falls into the following categories:

Result	Cause
(a) Overheating or burning	1. Building up too much heat during pre-heating and flashing. 2. Not cutting current off as butting commences. 3. Too high a tapping. 4. Incorrect protrusion.
(b) Oxides and inclusions in weld.	1. Insufficient plastic zone. 2. Inadequate butting pressure. 3. Not enough heat built up. 4. High tapping causing large cavity depth. 5. Burning too much material away during flashing so that there is insufficient left to upset.
(c) Weld not completed over all area.	1. Insufficient heat. 2. Insufficient butting pressure. 3. Fluctuations in mains voltage.
(d) Cracks on or near weld.	1. Heat too localised. 2. Too much heat built up. 3. Insufficient butting pressure. 4. Insufficient material upset. 5. Too high a tapping. 6. Fluctuations in mains voltage.
(e) Burn marks.	1. Too high a tapping. 2. Incorrect protrusion. 3. Poor contact between component and electrodes due to scale, grease or worn and dirty jaws.

During flashing, the elimination of oxygen round the weld is partly effected by gases formed by the combustion of the metal and the force of expulsion of the molten particles, the exclusion of oxygen being more positive on higher tappings than on lower ones. The high tappings which pass more current give a greater heat and better screening effects. Therefore a balance must be made between a high tapping which results in a greater cavity depth on the flashing surfaces, or a lower one which may allow a certain amount of oxidation to form on the edges of the weld. The selection of the tapping for each particular size and section is therefore very important.

Butting pressure (as stressed previously under that heading) is very important, and it is better to use more than the required pressure, rather than less. A solid round weld requires the heaviest pressure, and as the weld area tends to elongate, the pressure needed becomes less. This condition remains until a point is reached where the width allows the heat to radiate much more easily. At this point the pressure must increase again. An example of this condition is the welding of thin blade "parting-off" tools.

Voltage variation can also be a cause of bad welds. The voltage drop caused by one machine at its own terminals will be almost identical every time it welds, and therefore will have no effect upon the quality of the weld. What can affect the weld is the variation produced by the operation of other welders' or electrical equipment connected to the same supply. This is particularly serious on automatic welding machines, as such variations have an effect upon the heat generated at the weld zone proportional to the square of the current. Thus whether the weld is satisfactory is dependent upon the amount of burn-off, time taken and butting pressure. If these happen to be adequate, a weld can still be made, but the chances of getting a faulty weld are greatly increased. On a manually operated machine the operator can usually counter any variations because he has full control of the weld cycle.

principal operations in the manufacture of H.S.S. tools

A butt welded tool is often looked upon as the poor relation of the carbide tipped tool. This is not true, for each have their own respective uses, and care must be taken in the manufacture of both. The operations involved in the manufacture of high speed steel tools are very few compared with multi-cutting edge tools such as milling cutters, but each operation plays an important part in the soundness of the tool.

The high speed steel portion, or tip, is produced to a very close specification and is usually of the 10% cobalt type. The tip is sawn from bar on either a hacksaw or bandsaw machine, with allowance made for the amount of material burnt off during welding. The tool shanks are parted off, sawn, or cut with an abrasive wheel, depending on the size and the section. The shanks of certain types of tools such as parting tools have to be milled to suit the shape of the tip.

The tips and shanks are then rumbled or shot blasted to remove any grease or scale which could cause a poor contact between the tool and the electrode during welding. The tools are flash butt welded and placed in a gas furnace at 900° to 1,000°C. for stress relieving. They are allowed to get a thorough soaking at this temperature before being raked into bins to cool. Certain tools whose shape makes them susceptible to cracking are given a full annealing as an extra precaution; this also leaves the tools in a softer condition for rough grinding.

Turning and planing tools are either rough ground by "off hand" methods using templates, or on oscillating grinding machines set to give the desired rakes and clearances. The tools are then hardened, usually in salt, tempered around 570° to 580°C. to give a Rockwell C reading of 63-65 and then blow-tested. The blow-test consists of giving each tool a sharp uniform blow on an anvil to ensure that it is thoroughly sound. The tools are then shot blasted, finish ground and marked. A crack detecting operation is carried out to show up any defects on the exterior of the tool, and after a further inspection for shape and dimension, the tools are ready for despatch.

conclusion

As will be realised from the foregoing, the soundness of the tool depends upon the soundness of the weld. Therefore, correct welding procedure is of major importance in the production of high speed steel tools. Experimentation is usually the quickest and most reliable way to establish production data, and decide on machine settings.

The fully automatic flash butt welding machine is now regarded as a precision machine tool in every respect and it is consistent and fast in operation. It is ideal for a mass production of welded tool and drill blanks, as well as for small quantities, and special tools.

The uses of flash butt welding are many, and this Paper attempts to cover only one small application

acknowledgment

The author wishes to express his thanks to the Directors of Arthur Balfour & Co. Ltd., for permission to publish this Paper.

THE NEW APPROACH TO PRODUCTION — concluded from page 784

part of these production factors is at present applied to useful productive work.

The New Approach is a philosophy for those who believe that this waste is unnecessary and that in line production and its derivative, automation, there is the possibility of an immediate and explosive leap forward in output and in world living standards.

bibliography

1. BURBIDGE, J. L. "*Standard Batch Control*". Macdonald & Evans, 8 John Street, London, W.C.1.
2. BURBIDGE, J. L. (1958) "*A New Approach to Production Control*". I.Prod.E. Journal, May.
3. BURBIDGE, J. L. (1959) "*Integrated Control*". The Manager, November.
4. FORRESTER, Jay W. (1958) "*Industrial Dynamics*". Harvard Business Review, July - August.
5. BURBIDGE, J. L. (1960) "*Are Our Stocks Really Necessary?*" The Manager, December.
6. Communication de M. MONGON au Xe Congres Internationale d'Organisation Scientifique. Paris 24 - 28. Juin, 1957.
7. BESSIERE, M. P. (No date) "*Pent-on envisager l'application de moyens nouveaux pour abaisser les prix de revient dans les fabrication mechaniques?*" Societe des Ingenieurs d'Automobile, 6e section technique, 39.
8. BURBIDGE, J. L. (1959) "*A New Approach to the Batch Quantity Decision*". Productivity Measurement Review. Paris. May.

Correspondence and comment on published Papers and matters of interest to production engineers are invited.
Communications should be addressed to :

THE EDITOR,
"THE PRODUCTION ENGINEER,"
10 CHESTERFIELD STREET,
MAYFAIR, LONDON, W.1.

SOME IMPRESSIONS OF RUSSIA TODAY

by JOHN M. BRICE, M.I.Prod.E.

Director,
Rockwell Machine Tool Co. Ltd.

SINCE my return from Russia I have been asked by a number of people to tell them what the country is like. It is difficult to convey a balanced impression, partly because there are so many contradictions and contrasts—even as regards the climate, which ranges from Arctic to sub-tropical—and partly because I have seen only Moscow, which I have reason to believe is no more typical of the rest of Russia than Paris is typical of France.

The Soviet Union (which is approximately the size of the whole North American continent) consists of fifteen Soviet Socialist Republics having a population in excess of 210,000,000 people, made up of over one hundred different nationalities, the Russians accounting for approximately half the total population. The U.S.S.R. is divided into 105 regional economic councils, in an attempt to decentralise the administration.

Mr. Brice, who is a Director of The Rockwell Machine Tool Company Ltd. (associated with The Coventry Gauge & Tool Company, Ltd)., and Chairman of the Institution's Editorial Committee, records here the impressions he received during his visits to Russia in connection with the British Industrial Trade Fair earlier this year, and includes some general comment on Russian affairs.

Moscow was founded in the middle of the twelfth century by Yuri Dolgoruki, whose statue is prominently situated just off Gorki Street (which is one of the main shopping streets) near the famous Aragui Georgian Restaurant. It is a large and still rapidly expanding city having some eight million inhabitants. The general architectural impression is somewhat unexciting, except for some pre-Revolution buildings such as the Bolshoi Theatre, which is both beautiful and well maintained. There are many churches, some of them very lovely in a semi-Oriental style, possibly typified by St. Basil's Cathedral on the Red Square, which has a large number of towers having large "onion" spires, either gilded or highly decorated. It is noticeable that many churches are being re-decorated, possibly more because they are part of Russia's history than for their religious value.

Another highlight is the Kremlin itself. This covers sixty-four acres and was an ancient fortress. It is completely surrounded by a well-kept and handsome wall. Within this wall are several museums containing treasures collected by various Czars; one hall, for instance, is devoted solely to presents from foreign ambassadors and contains anything from jewel-studded crowns and golden dinner services to coaches specially designed for Royal children, one complete with six stuffed Arab horses. There is of course also the Kremlin Palace itself, where the sessions of the Supreme Soviet of the U.S.S.R. are held. At the moment a very good-looking modern building is being erected, which will be known as "Palace of Congresses." As the name implies, it will be used for

large assemblies, including the 22nd Congress of the Soviet Communist Party. The main hall in this building seats 6,000 and can also be used as a theatre and cinema. This building is evidence of a new trend in architecture in the U.S.S.R., more functional in style, but no less impressive. Eleven churches are housed within the walls, including the Uspensky Cathedral where the coronations of the Czars took place. In pre-Revolution days the Kremlin was the "Holy City" of Russia.

exhibition of economic achievement

We inspected the U.S.S.R. Permanent Exhibition of Economic Achievement, which is housed on the outskirts of Moscow and is on a fantastic scale. One would need many days to see everything, as the Exhibition must cover over three hundred acres and has its own trolleybus service. It contains seventy-eight pavilions, in addition to many other buildings, fountains and recreation zones. We visited one hall devoted to Machine Tools. Here one of each of their latest machine tools is always on view. Some of the halls are specialised, such as the Machine Tool Hall, but in addition there are fifteen halls showing the cultural and economic achievements of each of the fifteen States which make up the Soviet Union.

Another hall we inspected is devoted to space research and achievement. Apart from various Sputniks and Luniks on view, one can see the actual nose cone from which one of their dogs was recovered. The brakes of the nose cone are badly burned as a result of the frictional heat created on re-entering the earth's atmosphere. One wonders how the dog was insulated to stop it being cooked alive.

In other parts of Moscow there are some buildings erected during the last twelve years or so which look as if they have been designed by a highly skilled confectioner specialising in icing wedding cakes, full of little pinnacles and towers, imposing but not necessarily pleasing to Western eyes—somehow a mixture of modern Western buildings and St. Pancras Station, but rather more stolid and severe. Typical buildings in this style are the Leningradska Hotel, the even larger Ukraine Hotel, and the gigantic Lomonossov University containing some 22,000 rooms, which is situated prominently on the Lenin Hill on the fringe of the city. From here one has a very fine view of the town and of the Moscow River which snakes through it, as well as of the enormous Lenin Stadium, which is really a collection of stadia—so that several different sporting events can take place simultaneously—containing a large number of gymnasia and extremely good dressing-room facilities.

Moscow streets are enormously wide, but even so the volume of traffic is surprising. The same traffic translated into our narrow streets would undoubtedly seem even greater. Most of the main streets have a central reservation marked off in white lines on which one is not normally allowed to drive, this strip being reserved for police cars, ambulances and the fire brigade.

The Russians have some very sensible traffic regulations, largely made possible by reason of the wide streets. One of these prohibits left-hand turns at most intersections, thus not cutting across traffic, and increasing the flow. It is usual, when wanting to make a left-hand turn, to go past the turning and then make a U-turn at a given point, filtering in and out of traffic, and then taking the next turn to the right. This works extremely well. Incidentally this arrangement also gives pedestrians a very much better chance, as filter traffic is strictly controlled so that there is a definite period when pedestrians can cross unharassed. Otherwise the Russians have something like our pedestrian crossings. These are not as strictly enforced as ours, and I failed to discover whether it is the agility of the pedestrian or the skill of the driver that saves people from being mown down.

public transport system

Moscow has excellent and frequent bus and trolleybus services. The underground system now covers a fairly wide network, having fifty stations, and is still being extended (there are 280 on the Greater London Underground system). The basis of the system is a circular route with radial arms going across. Their trains are wider than ours, have a very high rate of acceleration and there is a frequent service. Each underground station has its own design, again very impressive but strange to our eyes, using mostly marble as building or facing material. There seems to be available a limitless variety in colouring and shading of Russian marble. There is evidence that the newer stations are architecturally simpler. Some of the escalators in use are much larger than any I have seen in the West, so much so that some people (including myself) keep their eyes shut when travelling on them! The handrails of these escalators run at the same speed as the moving stair—London Transport please note!

On both buses and underground there is a standard fare as in Paris, irrespective of the distance, which substantially reduces staffing requirements. On the underground one's ticket is torn in half when one goes through the barrier. Apart from that there is no further check and thus there is no need to have ticket collectors. In buses one puts one's money in a box and takes a ticket. There is no conductor and the system relies entirely on trust.

Moscow also boasts very many taxis, which are freely available during the day but difficult to get hold of after midnight.

The city itself is spotlessly clean, throwing litter on the street being prohibited, and all the main thoroughfares being washed at night by large lorries with water tanks and revolving brushes.

shopping facilities

Before the revolution the GUM Store housed about 270 entirely separate shops. This store was reopened only in recent years, but it is still essentially a collection of small shops rather than a big store, employing a staff of some four thousand, and selling all kinds of wares, from clothing to household goods and food. There is also a champagne bar, and automatic vending machines giving shots of a popular perfume.

Possibly the Bond Street of Moscow is Gorki Street, where one can find food and clothing shops, bookshops and many others. Although there are now many shops in Moscow and many new ones being built in new districts, from time to time one sees quite long queues. How the Russian housewife knows when a consignment of a particular commodity has arrived in a given shop, I do not know. There must be some kind of a grapevine. The Russians will tell you that there are no queues in their country and that people are simply taking their turn.

Food prices seem generally very high, and I am sure that the Russians spend a large part of their income on food. With the exception of so-called "cultural goods" such as books, gramophone records, etc., prices are very high by Western standards, but unlike in the West, the trend is for prices to come down.

The Russian people on the whole are happy-go-lucky and friendly and many have an extremely good sense of humour, very similar to ours. The police seem friendly and do not display the officiousness found in some European countries.

It is apparent that whilst the standard of living in Moscow is nothing like as high as ours, it seems to be rising at a rapid rate, so much so that it is interesting to consider what it might be in five or ten years' time.

More and more Western people visit the Soviet Union every year, either on business or as tourists. Moscow is well under four hours away from London by direct jet flight. This traffic is likely to increase, reaching a peak in 1967, when the World Fair will be held in Moscow.

the housing problem

The Russians make no secret of the fact that housing is their greatest problem. I gather they have now reached the stage where they have replaced all the houses that were destroyed during the War. Whole new areas are springing up on the outskirts of Moscow, containing very large blocks of flats, some brick but very many constructed of pre-cast concrete, even to floors and ceilings, making building much more of an assembly job. Rents are said to be very low.

Some of the blocks of flats now being built on the outskirts of Moscow are district heated, and all blocks of flats built in Moscow since the War have central heating to combat the exceedingly low winter temperatures.

The present seven-year plan which ends in 1965 calls for the building of 22,000,000 homes in the Soviet Union, representing fifty new towns each of the size of Liverpool.

One Russian official told me that they could solve the housing problem for the Muscovites much more easily if they could only stop people coming into the city, but the town's growing industries alone make this difficult. Obviously very many families are still living in one room and for some time shortly after the War all new blocks consisted of one-room flatlets; but flats now being constructed have two or three rooms, which shows the tendency towards better living conditions.

Although one sees spivs and teddy boys, it would seem that on the whole Moscow is a clean-living city. For instance, there are no night clubs. On the whole, the people are by our standards somewhat conservative and I feel sure that the short skirts currently worn by English girls would shock them.

Even Russians who are not party members are naturally patriotic and proud of their achievements and absolutely convinced that their leaders are working for them and for peace. They are, of course, equally convinced that it is only a matter of time before the rest of the world will have a similar system, as their system seems to them so much superior. Undoubtedly there are a lot of good trends in Russia of which we do not seem to be aware.

the working tempo

It is surprising to note, when walking through Russian factories, that the workers do not seem to work any harder than they do here. The Russians normally work a seven-hour day, sometimes with one shift and sometimes with two shifts, but overtime is something most unusual, the necessity for which would be blamed on bad management and bad planning. I should mention that the seven-hour day was introduced in 1960 for most workers, but coalminers working underground and others who work in relatively unhealthy surroundings now work a six-hour day only. All workers have four weeks' paid holiday and workers and others alike look extremely well fed, although their clothing is a little drab. However, efforts are now being made to make people a little more fashion-conscious, a sure sign that the standard of living is rising.

They obviously look after their children very well, and the children themselves seem extremely happy. During the last few days of my stay in Moscow, thousands of children left every day for various camps in the country, such as the Ural Mountains, the Caucasian Mountains, Black Sea, the Crimea, etc., for a six weeks' stay. Of course this not only ensures their physical health, but undoubtedly the opportunity is also used for a certain amount of political instruction.

The actual percentage of Communist Party members is very small (about ten million). Party members in all walks of life are the élite of the population and it seems in practice that they devote their lives to the party cause, which means that they have all kinds of functions and tasks to fulfil during their spare time. Whilst I have no proof, I think it is a reasonable deduction to make that people in high positions, whether a Director in charge of a factory, or of the Bolshoi Theatre, or an importing organisation, are party members.

the woman's place

Women do not seem to have complete equality with men in every way (for instance, it is "not done" for a young lady, or young ladies, to visit hotels,

restaurants or places where there is dancing, without male company), but they receive the same pay for the same work. This seems to bring about a slightly different allocation of work. For instance, in the two machine tool factories which I visited there were very few women employed, the notable exception being the crane drivers. Women are employed on this work in factories and on building sites. Presumably crane driving itself is not heavy work, but requires judgment and a sense of responsibility. In restaurants, waiters and waitresses seem to be about equal in numbers, but it was startling to see a woman as captain of a large Moscow river steamer. I gather that most doctors in the Soviet Union are women. Quite a number of bus and trolley-bus drivers are women, and so were the drivers of all the road rollers which I saw.

Undoubtedly there are new classes in the Soviet Union, as people who hold important positions have all kinds of additional benefits apart from very much higher pay, such as better flats, dachas (which can be anything from a one-roomed country cottage to a large country house), cars and limousines, chauffeur-driven or otherwise, depending on their position.

It is interesting to note that a number of so-called capitalist institutions are creeping into the Soviet economy. For instance, there are official lotteries, and more interesting, perhaps, savings banks are paying 3% interest on a quick withdrawal basis and 3½% interest for longer periods.

the thirst for knowledge

Russian people have a tremendous thirst for knowledge and it seems to me that this has to some extent taken the place of religion. I believe that it stems from the idea of wanting to improve, mechanise and automate everything as much as possible for the good of everybody, and to enable working hours—which are at present seven hours a day and six hours on Saturday, making a forty-one hour week—to be still further reduced, giving them more time for recreation, such as sports, weekends in the country, visits to theatres, museums, etc.

This thirst for knowledge was one of the outstanding features of the British Trade Fair, which was visited by one and a quarter million people, who considered themselves lucky to have been able to obtain a ticket. It was not unusual to be accosted in the street and asked for a ticket for the Trade Fair, but as the distribution of these lay in the hands of the Russian Chamber of Commerce, British exhibitors had no tickets to give.

This Trade Fair was conceived, organised and staged in a grand manner, although with perhaps too little regard for cost, on a purely private enterprise basis, by Messrs. Industrial & Trade Fairs Ltd., whose Managing Director is Mr. V. G. Sherren and which is owned jointly by two publishing groups, namely Newnes (controlled by Odhams) and the Financial Times. When arranging for this Exhibition one of the conditions the Russians made was that they should be given similar opportunities in this country; hence the Russian Exhibition at Earls Court.

The Exhibition on the whole must have made a tremendous impact on the Russian people in many different ways. First of all, it was the first opportunity they have had of meeting such a large number of British people. Secondly, they appreciated the fact that this was a selling exhibition and that a lot of the equipment shown was actually working. I gather that this was not so at the previously held American Exhibition, which was on a much smaller scale and which to a large extent, apparently, consisted of photographic displays or static exhibits. It would seem that the Americans tended to concentrate on selling the "American way of life," whereas the British Trade Fair showed the latest technical developments covering all aspects of industry. Thirdly, the large hall in which our stand was situated looked very pleasing indeed. This was designed by Jack Howe, with some French and Russian help, and was mostly in glass and aluminium, the proportions of which were just right. The design of this hall is very different from Russian architecture and was much admired.

More often than not we had so many people on our stand that it was really difficult to move, and as it was impossible to tell by appearance alone whether an individual was a Director of a plant or someone completely unconnected with engineering, we tried to devote some time to as many people as possible, mostly through Russian interpreters and our own Russian-speaking member, sometimes in "pidgin" English and quite often in German, of which a surprisingly large number of Russians have some knowledge. (This is largely due to the fact that German was the first foreign language before the last War; also, quite a number of Russians learned to speak some German either whilst prisoners of war or as members of the Russian army of occupation). The first European language today is English, although very many people are, of course, studying Chinese.

the Trade Fair

The Trade Fair itself was held in the Sokolniki Park, which lies on the north-eastern fringe of the city and covers an area of some fifteen hundred acres, several times the size of Hyde Park. The part outside the exhibition area is partly grassland and partly forest, and is used for the people's recreation. It contains many swings, roundabouts and playgrounds for children of all ages, and includes a stadium and swimming pool, as well as an all-the-year-round skating rink. The area fenced off for the Exhibition contained not only the two new large British Halls, but also a pavilion built by the Americans and a Russian Hall. There was plenty of space for outdoor exhibits. In one part, for instance, Vickers had their two-storey pavilion. Over seven hundred companies participated in the British Trade Fair, covering not only plant and machinery, electrical and electronic equipment, food making and wrapping and capping machinery, materials and plastics, but also textile machinery, clothing and textiles, transport vehicles, office machinery, footwear and leather, even musical instruments, books, toys and games.

The Fair was open for seventeen days, from 9 a.m. to 9 p.m. including Saturdays and Sundays, and all exhibitors were inundated with enquiries from scientists, technologists and representatives from Russia and foreign (Eastern bloc) delegations, State Planning Committees, Economic Councils, etc. These enquiries came not only from central organisations in Moscow, but thousands of technicians, factory managers, directors, etc., came from all parts of the Soviet Union to visit the Fair, very many from the North-Western industrial area around Leningrad, also many from districts in the Ukraine, from the Caucasus, the Central Asian republics, Siberia, the Far East and the Crimea. Thus for the first time we had an opportunity of talking to those who already use our machines and to those who might one day do so.

a great attraction

Queues of ticket-holders four deep could sometimes be seen stretching over a mile. It has been estimated that an average of 120 persons entered the Exhibition every minute that it was open to the public. The Band of the Argyll and Sutherland Highlanders, dressed in their splendid uniform complete with kilts, was a great success with the Russian public. Literally thousands of people crowded in to try to hear and see them.

At one time the Exhibition authorities were under strong pressure to extend the duration of the Exhibition, which would, however, have been very difficult for some British exhibitors, as well as for the Exhibition authorities, in view of the fact that the French Exhibition was following the British Exhibition.

In Russia few things happen quickly. As a matter of fact, whilst we in the West might think that the word one hears most often is "No," the favourite word in Russia is "Tomorrow," which goes with their happy-go-lucky attitude, and which makes one think that without their tight régime they would be very much more backward in scientific and engineering achievements than they are. There was one machine in particular on our stand which aroused an exceptional amount of interest, although the speeds of production and the accuracy that we were able to achieve were not believed until we actually demonstrated the machine. It was surprising, therefore, to find out that even a few days after the end of the Exhibition not a single enquiry for this machine had filtered through to the State Machinery Importing Organisation.

On the other hand, a Factory Director wanted to have a particular machine that we exhibited. He had a lot of pull, so much so that his engineer was present on the following day at a joint meeting at Stankoimport. In other words, some people in influential positions can obviously cut through red tape.

State Machinery Importing Organisation

At this stage I should like to explain that the choice of purchase of a foreign machine lies with the State Machinery Importing Organisation and that the user can only request an imported machine if (a) his own regional state planning authority has sanctioned the necessary expenditure and (b) the end user has received a certificate from the State Scientific and Economic Planning Commission giving him permission to expend the amount of foreign currency.

We had eleven separate meetings at Stankoimport (Machinery Importing Organisation) negotiating contracts, discussing machine features, accuracies, equipment, prices, discounts and deliveries, and also separate meetings with some of the Stankoimport Engineers as well as with some of their customers. Although negotiations were sometimes difficult, the Russians were really extremely helpful and courteous to us. The lady interpreters employed by this organisation were extremely good and interpreted fluently, never hesitating even when unusual technical terms were being used.

It is interesting to note that Civil Servants, such as those employed by Stankoimport, retire with an annual pension of two-thirds of the average of their last five years' salary, men at sixty and women at fifty-five.

a favourable atmosphere

A favourable tone was set through a happy combination of circumstances: the undoubtedly good Exhibition in itself and the fact that Nikita Kruschev came unexpectedly to the opening. This good feeling was still further strengthened when the Moscow City Council, at Mr. Kruschev's instigation, organised a most wonderful reception for some of us at very short notice, at which Mr. Kruschev was not only present but was most affable, in spite of his often repeated demand for Britain to buy more Russian goods and a certain amount of Soviet oil. This set the pattern for speeches made by lesser officials, i.e. two-way trade. Taking the sterling area as a whole, we seem to be in balance to the Soviet Union (about eighty-six million pounds per annum), but taking Great Britain alone we apparently sell more to Russia than we buy from them. The wish to sell oil to this country has become a fixed idea with them and my personal view is that a token import of oil, such as perhaps the difference between our present and our rising consumption, would help to strengthen relations further and enable the Russians to do more long-term planning. This would not necessitate price cutting here, which so many people fear, if the large oil companies would buy this relatively small percentage of oil from the Russians and feed it into their own channels, thus not having separate distribution outlets, in a similar way to that in which the diamond importation problem was settled. Last year actually we sold a lot less to Russia than we bought, but as they are buying a lot of Australian wool and Malayan rubber, to mention only two commodities, they claim to have little sterling to spare. Possibly they have not heard of convertibility and also it seems that they do not want to pay in gold.

This two-way trading theme prevailed at a dinner which I organised on behalf of the seven members of the Machine Tool Trades Association for various Russian officials, including the President and Vice-President of the Machinery Importing Organisation,

also Directors of two machine tool building plants and the Director of their Machine Tool Research Association and Development Organisation. At this dinner Sir Stanley Harley made an excellent speech on behalf of the Machine Tool Trades Association contingent, which was translated into Russian by Mr. D. G. Walder, and was replied to by Mr. Timofaev, Director of Stankoimport. The dinner was a great success and was seemingly appreciated by both Russian and British participants.

factory visits

A number of us visited two machine tool factories and the Machine Tool Development and Research Institute. These visits were very efficiently arranged for us by our friends at Stankoimport.

The first factory visited, Orüzhonikidze, is surely one that could not have been seen by Professor Melman. It is housed on old premises built, so we were told, by young people in 1932. These works are devoted in the main to the manufacture of transfer lines and unit heads. Unit heads are standardised in the Soviet Union and the claim has been made that any unit head of a given size can be interchanged with one made in different works. However, this interchange necessitates a lot of packing pieces and washers, as we were able to witness.

This works is suffering from the old-fashioned building and cramped conditions, and from the lack of modern machine tools. It contained quite a number of pre-war British, American and German machines, and a new Russian-built machine which they designate a jig borer but which was more like a three-headed plano-miller, was just being installed. They claim to employ something in the region of 4,000 people and still have 750 of the men who started work there in 1932.

Affiliated to this factory is a technical school, technical laboratory and an apprentice training scheme. We were surprised to find that the total apprenticeship period is two years; one year's theory, one year's work in the plant. Whilst ours may be excessively long, it seems to me that two years is a very short period indeed.

As in all other Russian factories, the output here is planned from year to year, the finalised programme being jointly drawn up by the director of the works, the workers' representatives, the suppliers' representatives and the customers' representatives, and these plans have then to be approved by the local state planning committee. These one-year plans are of course part of a larger seven-year plan which is said to be running ahead of schedule and which originally aimed at an increase of 80% in industrial production over a seven-year period, but which has now been adjusted to 100%. It is also interesting to note that the total industrial production is alleged to have been increased by over 22% during 1960, yet only a 17% increase had been planned.

A bonus of up to 40% can be earned by workers, technicians and the director if the planned output is exceeded, and I gathered that it is only in exceptional circumstances that this bonus is not paid. As the people do not seem to work any harder than they do here, and as the production methods employed were most conventional, one can only assume that the agreed target is not set particularly high.

It is somewhat dangerous to draw too many conclusions after seeing only two or three factories. A more balanced picture of the situation is perhaps obtained when one remembers what the Soviet authorities claim, namely, that last year transfer production lines were introduced into Soviet factories at the rate of more than fifty per week.

The other works visited was the famous lathe factory known as Krasnaya Proletariya (Red Proletariat). This factory employs some 6,000 people, and is 25 years old. It manufactures all kinds of lathes, from small centre lathes to large wheel turning lathes, chucking and copying machines, etc., as well as an eight-spindle vertical automatic, but the outstanding feature of this plant is the mass production of fifty Model No. K62 lathes per day, approximately 8in. centre height and 40in. between centres. This machine appears to be a good modern lathe, having 24 spindle speeds up to 2,000 r.p.m. (3,000 optional) 48 feeds for cross-slide and saddle and rapid traverse to carriage and saddle by push-button incorporated in directional control joystick. The machine looks rugged and is driven by a 10 kilowatt motor, a separate motor fitted to the end of the lathe bed being used for the rapid motions. The machine is sold complete with coolant pump and piping, tray and electrical equipment.

manufacturing processes

There were no unusual manufacturing processes to be seen; the main unusual feature was seeing multi-spindle drill heads and transfer lines being used for making lathes rather than, for instance, diesel engines, and it is only possible for the Russians to do this because they have a guaranteed market for their machines. However, a few interesting facts remain in my memory. One is that the lathe bed (which by the way can be supplied in various lengths apart from the standard machine length) is milled and not planed, using a plano-milling machine with a horizontal bridge-type cutter-bar employing some six cutters and milling cutters fitted to the side heads below the cutter head. Flame hardening is considered old-fashioned, the Russians claiming to have had much better results with the induction hardening they are now using. Another interesting feature is the fact that cross-slide, saddle ways and bed ways are ground, using in each case cup wheels. The finish obtained is quite rough, as can be felt when passing one's fingernail over these surfaces, but this is probably done on purpose to avoid "stiction" problems found when having one ground machine member sliding over another.

Of further interest is that three shifts are employed at this works. Two are production shifts and the third one a changeover shift. Let me describe two production lines, one for making gears and the other for spline shafts.

The gear line is fully automated and starts with a forged blank which is broached, turned on one side,

moved to another machine, turned on the other side and moved to the next machine where the face is turned. A further machine carries out the gear cutting, another the shaving of the gear, from where it is picked up automatically and stacked. This line, using the same machines and the same work-holding and automation equipment, is designed to manufacture any of the gears used in this lathe. The automation equipment is extremely simple and sometimes a little crude, but it works extremely well (we in the West tend to over-complicate automation equipment).

The other line, namely, the spline-shaft line, is perhaps even more interesting. This machine line will handle any one of 27 or 28 different spline shafts used on the mass-produced lathe and by other lathes manufactured in the factory. Thus, a day's production secures a month's supply of any one particular shaft. It was interesting to note that these shafts varied from approximately 8in. to 26in. in length. Some required cylindrical grinding of journals at one end and some at both ends, and yet the same machine line was used to cover this tremendous variation in type and size of spline shaft.

The third shift was concerned both with change-over of automated lines as described above, and with plant maintenance.

It is claimed that the total labour hours used for building the lathes is under 200, and that this includes not only painting but the hours used at the foundry. This does not seem to me to be a very low figure considering the high degree of mechanisation.

On completion of the headstock assembly, the headstock was tested for noise, spindle run-out, spindle parallel to base, etc., whilst on a moving band prior to assembly to the bed. The assembly of the headstock to the bed was also carried out on a moving band and so were all other inspection operations considered necessary. I had the impression that not too much time was spent on inspection. Periodically a machine would be pulled out of the line for a screw to be cut and the cut screw would then be tested in the laboratory, where the facilities seemed only just adequate.

It was queried why all machines were made complete with leadscrew when only about 10% of the lathes might be used with leadscrew. The reply was the same as in the West—"It would cost us more to leave it out."

The general impression one gains when walking through these works is one of extremely poor plant maintenance. Inspection room equipment is largely of German, British and American origin, and in most cases fairly old.

visit to ENIMS

The visit to ENIMS (in Russian this stands for Experimental Scientific Institute for Metal Cutting Machinery) was most interesting. The Deputy Director, Mr. Zyzanev, after giving us a talk, showed us round. We had met him previously at our dinner (together with the Directors of the two machine tool building plants).

This Institute is not very much concerned with pure research, and I think it would be fair to say that it carries out mostly development work. Also of interest to note here is that apart from developing machines, they seem to be producing not only prototypes, but at a further stage pre-production batches of six or more machines of one kind. This Institute has been responsible for developing the famous Russian spark erosion machines, using 100 kilowatt equipment. It seems that for finishing operations their machine is no more productive than anybody else's, although they claim that for roughing operations their metal removing rate is eight times that of any Western machine, but the surface obtained was exceedingly rough. Also, on finishing operations the surface did not appear to be as good as we know it here, although perhaps there was not much difference. They might have been able to obtain a better finish had they used some good filtration equipment for their electrolyte.

use of graphite

It is interesting to note that the Russians find graphite far more suitable than copper, brass, steel or aluminium for making electrodes. They claim that the wear on the electrodes made from graphite is considerably less than on those made from other materials. In addition it can be shaped and machined very easily, or even moulded from a wooden pattern.

Another machine which they have developed is a gear rolling machine. This produces gears of the accuracy required for tractors, but not better. It is, however, a very fast operation and owing to the favourable grain structure and compacting of metal achieved, steels of a lower grade can be employed and the gears produced on these machines are very satisfactory in use. They employ two machines, one at which the blank is induction heated, and the rolling takes place in the hot condition; and another for finishing rolling by cold operation.

Another machine developed at this Institute is a tape-controlled face cam milling machine. This would seem an interesting exercise, but of very limited application.

A further development which has come out of this Institute is a spline shaving machine. The tooling for this requires very great accuracy in making, and consists of a holder with sliding cutters corresponding to the number of splines which are cam operated by a ring shrouding the whole assembly. This was most interesting.

Also seen was a machine, or rather, a fixture which developed into a machine, for gear tooth rounding, on which both sides of a gear tooth were rounded simultaneously.

We were also able to witness the production of a batch of gear grinding machines using a multi-ribbed wheel mounted on a horizontal spindle, reciprocating vertically but moving horizontally with the speed of the gear rotation, thus using the generating principle, over a few teeth at a time.

Other new machines to be seen there were the prototypes of ultrasonic machines, using 4 Kilowatts,

and plunge cylindrical grinding machines of a very low construction (to reduce vibration) where the work-pieces were mounted between centres above the grinding wheel. They claim that this facilitates automatic loading, as it undoubtedly does. They were also manufacturing automatic dynamic balancing machines to be incorporated into transfer lines.

Another interesting machine was an internal grinding machine of the vertical type, where they employ a separate spindle for roughing and another for finish grinding, claiming that this increases the speed of production because it is possible to use the correct grade of wheel for the roughing and the correct grade of wheel for the finishing. Also I suspect that it is easier to maintain extreme accuracy on a vertical machine than on a horizontal machine.

machine tool testing

The Institute is also responsible for the testing of foreign machine tools, and I understand that repeat orders for machine tools depend on their favourable report. This organisation is further responsible for vetting and approving the design of machine tools designed anywhere in the Soviet Union. In other words, no Russian machine tool works can go ahead with a new machine unless it has first been approved by ENIMS. I gather that the two highly automated factories in Russia, one for producing ball bearings and the other for making automobile pistons, were planned by them.

During the discussion with the Head of ENIMS we were told that there are approximately 2,000,000 general purpose machine tools in the Soviet Union. As their present output of machine tools is in the region of 120,000 per annum it is clear that this output, taking a replacement programme of just over 5%, cannot cope with much expansion. Taking a 10% replacement programme, 200,000 machine tools per annum would be required. It is claimed that they will have reached a production of 220,000 machine tools in five years' time.

manufacturing policy

Undoubtedly their policy is to manufacture standard machines and unit head machines in large quantities, only purchasing from the West those which are of a special nature and which are not required in such large numbers. The only exceptions are, of course, the machines which N.A.T.O. have put on their Embargo List and which the Russians are forced to produce themselves. We saw a very good example of this in the form of a copy of a gear-cutting machine which they claimed to have improved. It was hard to tell whether or not this was so. The machine we saw certainly looked very good indeed. I doubt very much whether they would have bothered to make this type of machine had it not been on the Embargo List.

In conclusion, the British Trade Fair in Moscow can be looked on as having been most successful, and for our Company especially so. This is largely due to having the right kind of specialised machinery, our previous contacts and contracts, and the experience gained by those of us who visited Moscow earlier this year.

One can see that there is a market for highly specialised precision machines, and possibly instruments. Considering the rapidly expanding standard of living in the U.S.S.R.—which is bringing about an increasing demand for consumer goods—and assuming that they will go on purchasing specialised machinery from the West, rather than producing this themselves, this market will continue (subject to conditions over which we have no control) provided that machine movements are power operated whenever possible, that machines contain as many automatic features as possible, and that the high standard of quality is maintained.

"END-ON" COURSES FOR HIGHER NATIONAL DIPLOMA IN MECHANICAL AND PRODUCTION ENGINEERING

The Borough Polytechnic, London, is now offering an alternative entry date to the first year of their course leading to Higher National Diploma in Mechanical and Production Engineering.

The new first year course will begin on 11th January, 1962, and will end in July. After a short works period, successful students will be eligible to join the second year of the course, which begins at the end of September.

In future years it is intended to offer first year courses starting both in September and in January. Further information may be obtained from: **The Principal, Borough Polytechnic, Borough Road, London, S.E.1.**

STARTING WITH QUALITY

by J. W. LAWRENCE, A.R.Ae.S., A.M.B.I.M.

ONE day in 1946, I had a visitor. He was a foreign-looking gentleman who marched into my office carrying a single-bar electric fire. Without a word, he placed it carefully on my desk, reached into his trouser pocket, withdrew an enormous roll of pound notes and put them on my blotter.

This performance was his way of establishing a good start to a proposition that I should manufacture similar electric fires in large quantities. He was a very persuasive fellow and for a while he talked unceasingly. The market was assured, he said, the things were easy to make, the price was good. All materials would be supplied from his "sources".

I picked up his sample fire and looked at it. It was a shoddy piece of work, without a brand name and obviously the crude product of some amateur. Nevertheless, I reflected, he probably could sell the things as the immediate post-war demand for all sorts of domestic appliances was indiscriminating. Also the price was good, whilst the "materials supplied" bit sounded too wonderful for words in those days.

I had had my own name over the door for a few weeks only and already the glamour of starting my own business had been dimmed by the host of problems I was facing. Armed with my savings, a dilapidated old church hall and four years' War experience of repairing aircraft heat exchangers, I had set out to "make a better mouse trap"—such optimism! This at a time when acres of lavishly-equipped, Government-sponsored aircraft component factories had been stopped like a Guardsman in mid-stride and were hungrily seeking every crumb of business in order to keep some semblance of production going. My prospects of getting an order were very slim at that time and even if I did pull one off, what about equipment? The sort of component I was interested in could not be made with simple tools, and the sum of money which had looked so impressive in my savings account was disappearing in terrifying fashion. Yet I was still miles from having even a primitive factory set up.

I looked hard at the wad of notes reposing on my desk. This was manna from heaven. Even with my limited facilities I could make a better fire than the one before me. No worries about materials, so I could be in production in a matter of days, and thus be in sight of earning some money to compensate the present one-way flow.

It was very tempting, and I sat half-listening to my voluble visitor who was still going on about the wonderful future for electric fires. "The future", I thought suddenly. "What happens when the big boys in electric fires get going? What about the recipe for success that I had repeated endlessly to myself during the dreary War years? 'Do something the other fellow can't or won't do or do it better'. Anybody could make and sell shoddy electric fires for a while, but they are essentially a product of the big and well-organised firms who will crush the back-street operators when they get back on to a peace-time footing." Memories of the thousands of times I had looked disgustedly at some defect of design or workmanship and resolved to do it better when I was my own master came crowding back and my mind cleared. "No", I said regretfully as he pocketed the roll of notes, "I'll stay with the job I set out to do".

a vital decision

No doubt it is a strange interpretation, but I now regard that decision as the most important Quality Control I have ever practised, for during the next fifteen years it was to lead me to some profit and much satisfaction.

Throughout the War years it had been the policy of the Ministry of Aircraft Production to divorce heat exchanger production from repair as far as was

possible, and though this was generally sound it did have the effect of insulating manufacturers from much of the trouble experienced in service.

Components which before the War had been individually-built with loving care by craftsmen were now being poured out in vast quantities. Skilled labour was diluted almost to vanishing point and new designs were rushed into production with only the barest minimum of proof testing. Lastly and perhaps mainly responsible for what happened, the official schedule of production acceptance tests, which had been just adequate as applied to fully developed designs built with fully-skilled labour, proved to be seriously lacking under these new conditions.

The components concerned were of many designs, several applications, and many sources of origin in Britain and in the United States of America, but they were all pressure vessels constructed of light gauge sheet metal and embodying thousands of soft-soldered or riveted joints.

In service they were subjected to pressure fluctuations, temperature fluctuations, vibration and, very often, severe mechanical stresses produced by badly-designed or improperly-applied mountings, to say nothing of enemy action which, however, accounted for only a small proportion of the very considerable unserviceability.

official testing

To ensure a product capable of giving reasonable service under these conditions, there was a series of official production acceptance tests of which the most onerous required that a static air pressure be applied for five minutes with the component immersed in water at room temperature. If no leaks appeared, then it was airworthy!

Needless to say, the number and nature of defects that got by this test were legion. Here are a few typical ones:

1. leaks which could be detected only at some critical pressure due to the localised stresses produced by the internal pressure;
2. leaks which could only be detected at some temperature within the operating range—again this was due to localised stress changes;
3. air pressure prevented from indicating leaks by presence of moisture, flux residues or other foreign matter in the cracks or crevices.

There were many other things that foxed this test and on one occasion approximately one hundred units, which had successfully passed tests and had received certification as airworthy, were delivered to the air-frame builders. There, they were placed on racks and left untouched for twelve hours or so when the test was repeated. This time the test said that over 40% were defective! Small wonder that the low reliability of these components was a matter of the gravest concern at one stage of the War.

To use a modern Quality Control term, the "feedback" on this appalling state of affairs was almost negligible at this time and consequently the manufacturers were largely unaware of these high failure rates or the reasons therefore. Like everyone else, they were under great pressure, some were several thousands of miles away, many were making components they had never made before and in any case their products were passing the tests which were supposed to set the quality standards laid down by the customer.

Eventually, however, some sort of feedback did get established and the resulting improvements in detail design, manufacturing techniques and workmanship put service reliability up to levels where it could at least be coped with until the end of the War.

Then what? For me, my own business. Having repaired, reworked, rectified, modified, rebuilt or otherwise made serviceable some tens of thousands of these things I thought that at least I knew how not to make them, and so I planned to set up a works and seek some orders.

First, however, I resolved that never again would I let that lying test deceive me and I set out to develop something which would tell the truth and all the truth. I had seen at first-hand what could happen when service troubles do not get reported back and it seemed to me that, short of keeping his own airplane, a manufacturer had to have some kind of rig that reproduced aircraft conditions.

test equipment

So, having survived the electric fire episode and a few similar temptations, I tackled the job of developing test equipment on which heat exchangers could be pressure-cycled, temperature-cycled and, in some versions, vibrated simultaneously. To calibrate the effects of these conditions, I was lucky in obtaining about a hundred components of differing manufacture and application which I proceeded to test to death. Some failed within minutes, others I couldn't kill at all and the now well-known fact began to emerge that sensibly applied environmental testing harms good components not at all, but it will kill off the duds quite quickly.

The results of this work were made available to all concerned. It got the blessing of the appropriate Ministry and Inspection Organisation and became a requirement for future production. I sold one or two of the rigs to those who did not care to make them and thus the very first product of my new company was—Environmental Testing.

From this my company went on to design and make its own aircraft heat exchangers and to develop specialist services of all sorts. It made some progress and a small branch was set up in Canada. Here, we worked right in the airport hangar on servicing and overhauling the components. We lived with the aircraft and with their maintenance and flying crews. No gaps in the feedback here!

Our sort of product had automotive applications, too, and we had ambitions in that direction so we undertook the repair and overhaul work on big

construction jobs. One such job made us responsible for the units on 1,500 items of equipment such as bulldozers, excavators, earthmovers and trucks used to build the famous railway from North Labrador down to Seven Islands on the St. Lawrence river. This equipment was cruelly abused night and day so here, also, the feedback was loud and clear.

In another case we were approached by the Canadian branch of a famous American truck manufacturer. They were operating an attractive scheme whereby, on the sale of a new truck, they would guarantee that the cost of repair and overhaul work would not exceed a certain sum for 100,000 miles. This scheme taught them much that they had not known about their own trucks, including the fact that the radiator would not last for 100,000 miles and at their request we did some environmental tests. This particular type of truck was used as the tractor unit of articulated vehicles and we found that in order to engage the automatic hitch to the trailer, the drivers crashed the truck back on to the trailer, causing the whole transmission and engine set-up to move forward, when the fan often carved up the radiator. We also found that, because of defective design, a certain gasket allowed oil to leak on to rubber engine mounts and this allowed the engine to thrash around. The top water-hose was short and stiff so the radiator had a rather rougher time than its designers had allowed for. All these things, plus a few inherent weaknesses of the radiator, were quite simply fixed, but again the ills and cures were found and proved by environmental tests and we got the job of reworking all radiators on new trucks supplied under the 100,000 miles scheme. This paved the way for further business.

This sort of experience led us into the design and manufacture of our own components for automotive applications and in its turn that, too, led us into other fields. Indeed, it seems there is no end to the exciting and challenging vistas that keep opening up and the company progresses and prospers, always however, "trying to do something the other fellow cannot or will not do, or doing it better". By commercial standards it has certainly succeeded and by achievement? Well—one of our aircraft products (still soft-soldered) has now done eleven million flying hours without failure.

What has all this got to do with Quality Control? Well, I know very little about the advanced applications. I do not understand statistics unless they are very simple. Curves and graphs baffle me, whilst computers and tape-controlled thingummies frighten me to death. I am a small-business man and my sort of Quality Control goes like this :—

First, you go out and live where your product or intended product lives. There, you keep your eyes and ears wide open. You find how the job likes your product, and, incidentally, that of your competitors. You get right into the skin of the man who is using your product and you make his problems yours. That is determining *"Fitness for the job"*.

You then come back and design into your product the things the job likes and design out of it the things it does not like. You also design a piece of equipment to be installed at your Goods Outward door. Not just an Inspector's table to measure dimensions, important as they are, but something that beats, bends, bangs, twists, heats, freezes or tortures the product just as the job does. This is *Environmental Testing.*

You then have a bad time with your design and production people, who will swear that your torture chamber is ruining their good product, and maybe it is. Maybe you will have to tame it down a bit until you make it do only what the job does but make it do it quicker. You want a set of conditions that breaks the bad ones fast, but does not harm the good ones. You then organise a post-mortem on the bad ones. "It's just one of those things", won't do. There has to be a reason why it failed and that must be found and when it is found you go back to its origin and *fix it—permanently.*

Because your *feedback* only has to travel from your Goods Outward door to your design and production people, they do something. A pile of failures in your own factory will get quite astonishing action, whereas the occasional complaint from a customer does not make nearly the same impact. "Occasional" is right because most customers do not complain; they just go elsewhere. On the other hand your environmental test tells you the complete story—"How many, where and why".

Practice this sort of Quality Control for a while and see what happens. First you get a bonus from identifying yourself closely with the job. You smell out improvements and new products ahead of others. You become a real professional in your field. Your customer no longer *tells* you what to do. He *asks* you what to do. You make something which is truly fit for the job and, unless your competitors have done likewise, you will find yourself one of the few.

In short, that sort of Quality Control pays!

"AUTOMATION — MEN AND MONEY"

a review of the B.C.A.C. Conference held in Harrogate in June, 1961

by D. S. EDGAR, Stud.I.Prod.E., S.I.Mech.E.

AFTER having digested the Papers and the points raised during discussion, three features are outstanding in my mind:—

1. automation in this country is practically non-existent;
2. management has not realised the full potential of automation;
3. automation cannot hope to succeed unless the fundamental principles of management are practised prior to the introduction of automation.

Whether or not Britain enters the Common Market, she must be prepared physically and mentally to meet the very fierce competition we can expect in many fields, if she is not to be beaten again and again. To counteract this, the three points I have raised must be radically altered.

Mr. Edgar is nearing the completion of his engineering apprenticeship with the de Havilland Aircraft Company at Hatfield.

He is a final year diploma student in the Industrial Engineering Department of Hatfield College of Technology and recently obtained his Higher National Diploma in Mechanical Engineering.

It must be remembered that automation does not just mean transfer lines or the like on the shop floor, but also the integration of data using computers. Before the introduction of automatic machine tools or computers in a firm, it requires a period of at least six months' preparation to determine how and where automation may be used. This will, in many cases, result in improvements being made with regard to general efficiency without even introducing automation.

Managers should, therefore, understand the problems in the use and consideration of automation, not only in case they wish to introduce it, but also for the benefit of the organisation prior to introducing it at all. It is these problems that I intend to review under the following headings:—

(a) Organisation and Management Structure
(b) Requirements of Automation
(c) Employee Consideration
(d) Forecasting

(a) organisation and management structure

When integrated and centralised data processing systems are used to control mechanised plants, costs, schedules, etc., computers can indicate clearly and regularly to management the places and processes which require immediate attention, if schedules and standards have to be met at the required cost. This information is, of course, completely up-to-date and can be acted upon immediately instead of using information weeks old. Thus the manager is on top of his job; he is using more precise and punctual information, and more time may be applied to other urgent work.

However, with the introduction of these new systems terms of reference must be changed, which ultimately causes unrest as people feel that their jobs are insecure and less clearly defined. It is, therefore, necessary for management to educate those

who are to be affected and to explain, assure, and satisfy, so that the new systems are received as blessings and not instruments of tyranny.

Prior to automation the management must use its authority, as well as the authority of the machine, which had to be closely watched by the operator. However, with the introduction of automation, the machines have a built-in impersonal authority and thus the management feels a loss of status.

Traditional management was built on the need to control and co-ordinate the activity of human beings to produce the required work or information from their machines; but with only, perhaps, one machine this problem changes. The traditional manager's job includes the use of authority, discretion, know-how, experience and decision-making. But integrated data processing reduces at least the area of discretion. Thus the areas of competence of managers become more sharply defined, although control and prediction become easier, and they rely more than ever on lower-level management for the accurate information regarding production operations.

To gather the full benefits of automation, members of management must have fully accepted the discipline entailed by its introduction and operation. To make this acceptance easier, and for that matter to ease the manager's tasks, whether working in a fully automated plant or not, their authorities, responsibilities, and fields of work must be clearly defined.

growth of original structures

It was mentioned at the Conference that the growth in numbers of industrial administrative officials and managers, reflects the growth of organised structures. Production Department managers, sales managers, accountants, cashiers, inspectors, training officers, publicity managers, research managers, and the rest emerged as specialised parts of the general management function, as industrial concerns increased in size. No matter how well we may organise growth of our companies, there is the danger of them becoming top-heavy and so dangerously unbalanced. As a gardener secures results by a constant and judicious use of the pruning shears, so management must constantly be prepared to keep the organisation tree (structure) within economical limits by pruning.

In large firms people tend to become lost and concealed in their own department, and as long as periodic reports appear in management circles everything tends to be accepted as working well. Small firms may not have the same amount of capital and as good machinery, but in many instances, as this is the case, efficiency is the key word and it could well be that many managers in large firms could learn a great deal from the organisation and management techniques used in these small firms.

Bureaucratic organisation, which we are told is the ideal form of organisation, lends itself readily to this "hanging-on", as this type of organisation acts on the principle of breaking down the problems facing a firm into a number of specialised problems and tasks. These are then pursued by individual members, each task being something distinct from the real tasks of the firm as a whole. The relevance of these tasks is the responsibility of top management.

I have mentioned the need for pruning and yet, at the Conference, it was stated that to combat the increasingly rapid change in industry's market and technical environment, new branches should be grown. This not only results in the features I have mentioned, but extra feelers must also be grown to facilitate communication so that the new branches can feed back and be fed with information. I would prefer instead to see existing departments, where possible, expanded and given a new delegation of responsibility.

(b) requirements of automation

At the Institution's 1955 Margate Conference on "The Automatic Factory—What Does it Mean?", a great deal of stress was laid on when and where to automate, the favourable conditions for automation being broadly contained under the following headings:—

1. scarcity of human labour;
2. hazardous and unhealthy operating conditions;
3. lagging output;
4. high cost;
5. quality;
6. repetitive operations.

I do not therefore intend to pursue these conditions any further, as information is readily obtainable, but I will instead concentrate on the cost requirements for automation.

Although automation, when correctly applied, provides an adequate financial return, the costs not only of the introduction of the equipment but of the actual running costs as well, must be assessed. Thus, prior to the introduction of automation top management has a clear picture of the expected financial situation.

It is sometimes assumed that automation can only be applied on a large scale and by large firms. This need not be so; small firms can, on introducing automation on a small scale, still expect a good financial return if automation is applied correctly. Automation, like variety reduction, tends to result in benefits in practically every department in a firm. These benefits have been summarised by the late Mr. Frank Woollard, as follow:—

1. a very considerable saving of direct labour;
2. a greater economy of floor space;
3. a much lower inventory of work in progress;
4. a much greater control of processing;
5. cheaper operating heads on the machines;
6. automatic inspection of the work piece;
7. much fuller utilisation of machine capacity.

From a perusal of these effects of automation it can be seen that financial return is possible in a reasonably short period. On the average this period is about three years for full recovery of outlay costs.

Prior to the introduction of automation, the firm must determine a clear-cut policy and objectives. Much of this concerns forecasting and economic

conditions, which will be dealt with later in this Paper but it also concerns the financial aspect of the firm, and management must be acquainted, not only with the installation cost, but also with overhead expenses, direct costs, and level of output.

Overhead Expenses — when preparing an assessment to show management the effect the project in hand will have on the Company's profit, it is necessary only to indicate the things that will change if the project is introduced and therefore present overhead charges, which will not alter, may be neglected. These, of course, must be introduced to produce a final picture, if other than just the effects of the project are required.

Product variety has a major effect on overheads incurred, and predictions must be prepared, based on whether product variety should be increased or decreased. The actual method of predicting product variety will be discussed later under the heading of forecasting.

There are some classes of expense, where variety is not such a major factor, as in management salaries, and others where volume of output is more important, as in inspection, despatch, transportation, etc., and the complete assessment should be based on all these classes of expense.

Direct Costs — manufacturing costs have to be assessed bearing in mind material, labour, and preparation costs. With regard to material it must be remembered that the introduction of automation may result in a change in manufacturing methods prior to using automatic equipment. Swarf, off-cuts, or residue, may increase or decrease in amount and scrap rates may radically alter. Once again this brings forth the need for the exchange of information, so that firms contemplating manufacturing work on automatic machines may obtain information regarding these points from other firms doing comparable work on similar machines.

Labour costs may be difficult to estimate, as not only will there be doubt as to the number of people required on shift work, resulting from the effects of mental fatigue, meal breaks, and other psychological reasons, but also the number of maintenance men has to be increased.

The preparation costs cover the initial cost, which is incurred once at the beginning of the project, namely, re-design of products and tooling-up, and also costs which are incurred repeatedly, such as setting tools at the start of each run, and the maintenance and re-setting of tools during each run.

Level of Output — estimates should be based on different levels of output, as forecasts of sales and output cannot be reliable. Thus it will be possible, using different levels, to determine whether automation will be beneficial even at a low output.

These points are, I think, the main factors to be considered and form the basis of estimating costs by a technical person. However, other factors concerning taxation, depreciation, return on investment, etc., must not be forgotten and should be considered by a person, or persons, in the financial side of the firm, namely the accountant. Thus the accountant and technical manager should work side by side.

(c) employee consideration

It would appear from the Conference that the Trades Unions, on behalf of their workers, have put a great deal of time and thought into the effects of automation. It was stated at the Conference that from a social point of view, there are a very considerable number of aspects which Trades Unions cannot pass over or arbitrarily thrust aside, without first devoting some study and serious consideration to their conditioning impact upon human relationships. It is in these aspects only that Trades Unions are able to accept, with certain essential reservations, that there is reason and probably justifiable reason for organised resistance to such labour-saving devices. However, these reasons are essentially based upon sectional interests and are only apprehensions and suspicions attached to the social effects of automation.

However, Trades Unions do realise that automation if properly applied brings with it higher productivity and therefore will result in higher wages and a shorter working week. Health, safety hazards, and industrial accidents may be safeguarded, and more physical and mental energy left for recreation at the end of the working day.

I believe that there are three fundamental points which require consideration by the Trades Unions :—

(1) prospect of unemployment;
(2) wage structures and incentives;
(3) collective bargaining.

Prospect of Unemployment — unemployment would be a real danger if automation were suddenly introduced in every factory, but as long as we can absorb the consequences of increased production as we introduce automation, then unemployment should not be too grave a danger. Since the Industrial Revolution we have absorbed our increased production by increasing wages and shorter working weeks, and this trend must continue, under a restraining influence of course.

The main effect of automation will be to reduce the number of machine operators in large scale production; however, these operators should be comfortably absorbed in storage departments, transport, maintenance, planning offices, and the toolroom, as these departments will expand with the introduction of automation. This will result in a shift from the shop floor to the offices and thus the number of white collar workers will increase as will the required skill of the employees.

Prior to the management introducing automation the employees must be approached and have the reasons for introducing automation explained to them, as well as the expected results. The way automation is received in a factory will be determined by the attitude of the management in their employee relationship.

Wage Structures and Incentives—overtime is sometimes used by workers in low-paid industries or

by employers to compensate for low basic rates. Automation may however make overtime redundant, as the need for automation is assessed on an output, which has to be strictly adhered to and must not fall too low nor rise too high.

Piece-work and incentives require more physical and/or mental effort, but the operator's control over production performance is limited when automation is used. Irrespective of this being a sound reason on its own, I believe that an operator is entitled to a regular wage packet of an even size and not a fluctuating one, i.e. where he gets a low basic rate maybe for several weeks on a long job, and then one large pay packet.

In a new plant a system of time rates is the most sensible way of tackling this problem, providing they are realistic when compared with the old piece-work rates that operated in the other part of the factory. This, of course, raises another tricky problem for management in that men may be working practically side by side, some on old and some on new automatic machines, both receiving the same rates. On the new machines the men may not require as much physical effort as their companions, but, they may require a greater amount of mental effort, which could be said to bring the different sets of men to an equivalent rate.

Organisation and production is so integrated that disputes over wages in one shop may result in a strike affecting the whole factory. This underlines the case for a simple wage structure based on high time rates. With automation there is a shift to more skilled workers, therefore there should not be much argument regarding unskilled workers being paid the same rate as skilled workers.

***Collective bargaining* —** to introduce high time rates, there must also be introduced more local negotiations as against national ones. Collective bargaining should take place in a factory or group of factories in a firm, as the degree of automation will vary from firm to firm, and national agreements will not be realistic over the whole country. This will, of course, make the work of Trade Union Officers and shop stewards far more important.

However, one obvious objection to this system of local collective bargaining, is that we are planning for the past and not the future and that the "laissez-faire" system will return. I would like to point out in answer to this that at the moment payment over the rate in some areas is not exactly unknown.

Apart from ensuring reasonable prosperity, management must be conscious of the social and psychological effects of automation on the operators. Automation removes the personal contact between operators and the work in hand and craftsmen lose their sense of pride in the work produced; this could result in general frustration. This and other causes of frustration can produce and aggravate symptoms of psychomatic illness. Management must be alive to this problem and reduce frustration by a conscious and active personnel policy, backed by a Personnel Division at a high level of management.

Operators must be given leadership and should be able to see their leaders on the shop floor. I deem the manager's office the worst asset a manager has, as he is always expected to be there. Instead he should spend some time on the shop floor, not just showing the flag but getting to know his employees. If employees do not feel a sense of belonging to the firm they cannot be expected to give of their best. This sense of being wanted and belonging to a firm is not peculiar to automated factories or offices, but should be practised by all firms, large or small, no matter what their function.

(d) forecasting

The growth in the use of the technique of forecasting has had a beneficial effect internationally, nationally, and with the individual undertakings. The cycle of high booms and low slumps has been brought under a restraining influence and the crests and troughs of boom and slump have been lessened.

The industrial undertaking working on forecasts based on sound investigation is better able to work within a controlled economy, and is in a much better position to wring the fullest possible advantage from automation.

Forecasting is a basic requirement of effective management and is the primary stage in planning. By setting firm reliable targets and guide lines for controlling operations under the command of managers, it is possible to minimise loss and waste of resources, time and money.

Forecasting is essentially an appraisal of ideas and information, and it must not be based on gimmicks, hunches, or bright ideas. Although the manager must make an ultimate decision, the decision should be based on the trends shown, if the appropriate data is applied to the appropriate fields at the right time.

To obtain the relevant data, management should rely on market research and their own past records. The economic and marketing data is available but it must be remembered that this data is "raw" and it must be interpreted by the individual firm. Past records can be relied upon if they are carefully scrutinised and re-assessed, and it must be remembered that they are records of the past, which need not necessarily repeat itself.

I have mentioned the availability of economic and marketing data, which we are told is available in large amounts. This may be so, but what is required is a central clearing house of data to avoid wasted effort, personnel, and money, by too many individual undertakings seeking similar information at the same time.

Installation of automatic machines for manufacture, or computers for data processing, which requires heavy investment and changes in production and/or administration, usually results in changes for the better for the prosperity of the firm. In order to ensure this prosperity the product range must be carefully controlled, as the operations involved in manufacture and administration are associated closely with the products made, especially as regards standardisation, specialisation and the use of coding systems.

Once the data has been collected, skilled staff is required to process and present it in a

manner as to be fully accepted if it is to be applied by production personnel. Thus the staff required must be more than pure mathematicians or economists. It appears that the training being given to accountant staff at present may result in their being well versed in preparing, presenting, and interpreting, management data; a function which they should be well equipped to do.

Forecasting must be made for a controllable period and should not be too ambitious regarding the future, as trends tend to become misty. Government policy and national economy play a great part in reliable forecasting but the effect of either of these can only be conjecture.

conclusions

Despite the possibility of being reproached for contradicting myself regarding forecasting, my long-term forecast is that the future development of automation is in the hands of the universities and colleges, the training ground for future managers.

Investigation and forecasting must be applied to the field of education so that we can look ahead and attempt to see the educational advances necessary to meet the technical requirements of industry in the future and gear our educational systems to meet these needs.

Managers must be created, and although much is learnt by management through practice, the basic processes of production and management techniques must be taught no matter how highly automated this country becomes. Once the basic principles have been grasped they can follow courses in programming, data processing, and the benefits and problems of automation.

There must be more, and better, co-operation between industry and centres of education; there must be more real service and less lip service to this need. Interchange of staffs between colleges and industry could, and should, be arranged and a variety of case studies made available for use in the class-room.

With the correct education, automation will be used to control and automate a process and not the work-people, and it will be applied to give this country prosperity and status, instead of poverty and unrest if applied incorrectly.

Letter to the Editor

From: **H. Ward** (lately Industrial Management Research Association)

Is British Industry Hamstrung by British People?

At this time when so many politicians, journalists, civil servants and academic folk want to talk about exports, it is pertinent to raise again, as I did long before the War, with the Manager of "The Times," that there is no way for an intelligent man to acquire a knowledge of industrial practice from books and other writings. One may read the newspapers from year end to year end for decades without finding articles which give any intimate picture of how millions of people spend their days.

In factories there are many thrills; there is love, ambition, struggle, hate and great human stories.

Those who write and talk and help mould opinion have read no adequate novel or book on industry. I purchase every one about which someone may say it describes life in factories. The list is not long. In none would I say that a real picture is presented. Our authors, playwrights, journalists do not know industry.

The main cause, to my mind, is the academic segregation, certainly not so true of Germany and the U.S.A., from ordinary life. Thus the products of the universities are less able than others to understand industry.

I cannot hand to any young graduate entering industry even one good general book about factory life. Our authors have told us intimately and endlessly about the lives of authors, journalists, clergy, politicians, doctors, and housewives. But of the real life of the other half of the population, who spend their days in factories and offices, we hear so little. Where would one find an adequate article or book really describing the feelings and work of a managing director as he does his daily work? The "Director" might find this idea useful and one which could take a place in many years of issues. Working directors themselves hardly know what the others do. How could any well-read arts-trained man form some picture of the daily life of a production engineer?

It is still true that great numbers of people have never closely examined even one factory. To most London clubmen, factories are a closed book.

During the War years, U.S. journals such as "The Saturday Evening Post" published live pictures of factory problems. This shows that the descriptive job can be done. But no such article has again appeared for many years.

How can those outside industry help if they have no thorough understanding of life in factories and an understanding up-to-date with adequate variety of theme?

NEW BRITISH STANDARDS

Copies of the following British Standards, recently issued, may be obtained from the British Standards Institution, 2 Park Street, London, W.1, at the prices stated.

B.S. 1728 Methods for the analysis of aluminium and aluminium alloys. **B.S. 1728 Part 12 : 1961** Silicon. 3s.

B.S. 3396 Woven glass fibre fabrics for plastics reinforcement. **B.S. 3396 Part 3 : 1961** Finished fabrics for use with polyester resin systems. 4s. 6d.

B.S. 3400 : 1961 Methods of test for dust in filling materials. 6s.

B.S. 3412 : 1961 Low density polythene materials for moulding and extrusion. 4s. 6d.

B.S. 3413 Drawbars and hitches for agricultural machines, implements and trailers. **B.S. 3413 Part 1 : 1961** Dimensions of ring hook automatic hitch. 3s.

B.S. 3417 Agricultural power take-off shafts and guards. **B.S. 3417 Part 1 : 1961** Power input connections and yokes. 5s.

B.S. 3419 : 1961 Tilley's aural and nasal forceps. 3s.6d.

B.S. 3422 : 1961 Laboratory deflection pH meters. 4s.

B.S. 3424 : 1961 Methods of test for coated fabrics. 15s.

B.S. 3425 : 1961 Measurement of noise emitted by motor vehicles. 3s.

B.S. 3426 : 1961 Portable poultry feeding appliances. 3s.

B.S. 3456 The testing and approval of domestic electrical appliances. **B.S. 3456 Part C : 1961** Electrical refrigerators and food freezers. 6s.

NEW CODES OF PRACTICE

C.P. 143 Sheet roof and wall coverings. **CP. 143 Part 2 : 1961** Galvanised corrugated steel. 7s. 6d.

CP. 1012 : 1961 The abatement and measurement of radio interference from electrical installations in civil aircraft. 10s.

NEW AIRCRAFT STANDARDS

A 211 : 1961 100° countersunk head steel bolts. 12s. 6d.

A 212 : 1961 Cadmium plated steel bolts of high metallurgical quality (unified hexagons, unified threads and close tolerance shanks) for aircraft. 5s.

C1 : 1961 Coupling dimensions for aircraft toilet flushing. 2s. 6d.

G 176 Cartridge fuses for aircraft. **G 176 Part 3 : 1961** Cartridge fuse-links (Type B). 12s. 6d.

REVISED BRITISH STANDARDS

B.S. 15 : 1961 Mild steel for general structural purposes. 5s.

B.S. 78 Cast iron spigot and socket pipes (vertically cast) and spigot and socket fittings. **B.S. 78 Part 1 : 1961** Pipes. 5s.

B.S. 427 Vickers hardness test. **B.S. 427 Part 1 : 1961** Testing of metals. 15s.

B.S. 691 : 1961 Clinical maximum thermometers. 4s.

B.S. 845 : 1961 Code for acceptance tests for industrial type boilers and steam generators. 7s. 6d.

B.S. 1121 Methods for the analysis of iron and steel. **B.S. 1121 Part 20 : 1961** Tin in iron and steel. 2s. 6d. **B.S. 1121 Part 37 : 1961** Nickel in iron and steel and permanent alloys. 4s.

B.S. 1179 : 1961 Glossary of terms used in the gas industry. 20s.

B.S. 1184 : 1961 Copper and copper alloy traps. 8s. 6d.

B.S. 1404 : 1961 Screen luminance for the projection of 35 mm. film on matt and directional screens. 7s. 6d.

B.S. 1452 : 1961 Grey iron castings. 5s.

B.S. 1596 : 1961 Fibreboard drums for oversea shipment. 5s.

B.S. 1613 : 1961 Method of determining the resolving power of lenses for cameras. 5s.

B.S. 1615 : 1961 Anodic oxidation coatings on aluminium. 7s. 6d.

B.S. 1972 : 1961 Polythene pipe (type 425) for cold water services. 4s. 6d.

B.S. 2048 Dimensions of fractional horse-power motors. **B.S. 2048 Part 1 : 1961** Motors for general use. 5s.

B.S. 2578 : 1961 Warp tubes for ring spinning and twisting frames. 4s. 6d.

B.S. 2609 : 1961 Drop wires for warp stop motions. 7s. 6d.

B.S. 2627 : 1961 Wrought aluminium for electrical purposes.
Wire (other than that used for overhead conductors). 4s. 6d.

AMENDMENT SLIPS

Please order amendment slips by quoting the reference number (PH...) and not the B.S. number.

B.S. 57 : 1951, PD 4329; B.S. 78 : 1938, PD 4316; B.S. 325 : 1947, PD 4330; B.S. 601, Part 1 : 1969, PD 4274; B.S. 604 : 1952, PD 4264; B.S. 771 : 1959, PD 4260; B.S. 846 : 1952, PD 4259; B.S. 916 : 1953, B.S.922 and B.S. 1691 : 1959, PD 4356; B.S. 949, Part 2 : 1954, PD 4253; B.S. 1016, Part 5 : 1957, PD 4309; B.S. 1121, Part 34 : 1955, PD 4149; B.S. 1083 : 1951, PD 4332; B.S. 1164 : 1952, PD 4266; B.S. 1265 : 1958, PD 4277; B.S. 1282 : 1959, PD 4252; B.S. 1465 : 1960, PD 4296; B.S. 1455 :

1956, PD 4265; B.S. 1500, Part 1 : 1958, PD 4300; B.S. 1673, Part 3 : 1951, PD 4261; B.S.1768 : 1951, PD 4333; B.S. 1769 : 1951, PD 4334; B.S. 1870, Part 1 : 1956, PD 4319; B.S.1875 : 1952, PD 4272; B.S. 1877 : 1955, PD 4297; B.S. 1981 : 1953, PD 4335; B.S. 2501 : 1954, PD 4267; B.S. 2502 : 1954, PD 4268; B.S. 2690 : 1956, PD 4220; B.S. 2708 : 1956, PD 4336; Addendum 1 : 1959 to B.S. 2880 : 1957, PD 4312; B.S. 2853 : 1957, PD 4279; B.S. 2901 : Part 1 : 1957, PD 4256; B.S. 3308 : 1960, PD 4293; B.S. 3456, PD 4314.

REVISED AIRCRAFT STANDARD

B.S. 4 F 33 : 1961 Flexible cotton rope for aeronautical purposes, 2s. 6d.

AMENDMENTS TO AIRCRAFT STANDARDS

B.S. SP 9 : 1949, PD 4262; G 173 : 1958, PD 4301.

REPRINTS

B.S. 122 : Part 1 : 1953 Milling cutters. 15s.

B.S. 215 : Part 2 : 1956 Steel cored aluminium conductors for overhead power transmission. 4s.

B.S. 559 : 1955 Electric signs and high-voltage luminous-discharge-tube installations. 6s.

B.S. 857 : 1954 Safety glass for land transport. 5s.

B.S. 1222 : 1945 Battery operated electric fences. 2s. 6d.

B.S. 1782 : 1951 Couplings for suction and delivery hose, other than fire hose couplings. 6s.

B.S. 1870 : Part 1 : 1956 Leather safety boots and shoes. 3s. 6d.

B.S. 2655 : Part 1 : 1958 Electric lifts, General Requirements. 15s.

B.S. 2752 : 1956 Vulcanised chloroprene rubber compounds. 3s.

B.S. 3139 : Part 1 : 1959 General grade bolts. High strength friction grip for structural engineering. 7s. 6d.

CP 339 : Part 3 : 1956 Domestic butane-gas-burning installations in boats, yachts and other vessels. 6s. 6d.

STANDARDS WITHDRAWN

B.S. 256 : 1936 Varnishes comprising : **B.S. 256** Interior oil varnish; **B.S. 257** Exterior oil varnish; **B.S. 258** Flatting or rubbing oil varnish; **B.S. 274** Extra hard drying varnish.

B.S. 1121 : Part 2 : 1953 Determination of nickel in permanent magnet alloys (replaced by **B.S. 1121 Part 37 : 1961).**

B.S. 1119 : 1943 High speed steel butt-welded blanks for shanked type cutting tools.

PUBLICATIONS BY INTERNATIONAL ORGANISATIONS

ISO/R 134 Non-screwed steel tubes for general purposes, 3s. 5d.

ISO/R 143 Weft pirns for automatic looms. 3s. 5d.

ISO/R 171 Determination of bulk factor of moulding materials. 2s. 3d.

ISO/R 172 Detection of free ammonia in phenol formaldehyde mouldings (qualitative method). 2s. 3d.

ISO/R 173 Determination of the percentage of styrene in polystyrene with WIJS solution. 2s. 3d.

ISO/R 174 Determination of viscosity number of polyvinylchloride resin in solution. 4s. 6d.

ISO/R 175 Determination of the resistance of plastics to chemical substances. 4s. 6d.

ISO/R 176 Determination of the loss of plasticisers by the activated carbon method. 4s. 6d.

ISO/R 177 Determination of migration of plasticisers. 4s. 6d.

ISO/R 178 Determination of flexural properties of rigid plastics. 5s. 8d.

ISO/R 179 Determination of the Charpy impact resistance of rigid plastics (Charpy impact flexural test). 7s. 11d.

ISO/R 180 Determination of the Izod impact resistance of rigid plastics. 6s. 9d.

ISO/R 181 Determination of incandescence resistance of rigid self-extinguishing thermosetting plastics. 4s. 6d.

ISO/R 182 Determination of the thermal stability of polyvinylchloride and related copolymers and their compounds by the Congo red method. 4s. 6d.

ISO/R 183 Determination of the bleeding of colourants. 2s. 3d.

ISO/R 184 Brinell hardness test of grey cast iron. 4s. 6d.

ISO/R 188 Accelerated ageing or simulated service tests on vulcanised natural or synthetic rubbers. 7s. 11d.

I.E.C. PUBLICATIONS

Publication I.E.C. 50(62) IEV 2nd Edition Waveguides. 18s. plus 6d. postage.

Publication I.E.C 67 Dimensions of electronic tubes and valves (English/Russian edition). 13s. 6d. plus 6d. postage.

Publication I.E.C. 125 General classification of ferromagnetic oxide materials and definition of terms. 20s. 3d. plus 6d. postage.

Publication I.E.C. 128 International code for the designation of photographic projector lamps. 13s. 6d. plus 6d. postage.

Publication I.E:C. 133 Dimensions for pot cores made of ferromagnetic oxides. 6s. 9d. plus 6d. postage.

NEW RESEARCH JOURNAL LAUNCHED

THE first issue of the Institution's new publication, *The International Journal of Production Research,* has now been published. The occasion was marked by a reception at Headquarters, when the President, Mr. Harold Burke, emphasised the importance of this new development and expressed the Institution's gratitude to Professor Norman Dudley, Honorary Editor of the Research Journal, and his associates for the work they have done in bringing the Journal to fruition.

In his editorial to the first issue, Professor Dudley states:

"Production is a meeting place of many disciplines, for the planning, organising and control of manufacturing industry necessitate an understanding of the nature and interaction of the technical, human and economic forces which are the agents of production. If this understanding can be advanced by bringing together Papers which would otherwise have been scattered throughout the literature of the several contributing sciences, the initiative of The Institution of Production Engineers in launching this International Research Journal will have been well justified. It is hoped that, for example, ergonomists will submit Papers on the characteristics of worker performance for the benefit of operational researchers and others who frequently have to make assumptions about such performance, and on the nature of human control systems which it might be advantageous to simulate in the design of automatic control systems. It is hoped to receive research reports on the psychological and sociological as well as on the economic and technical aspects of production control.

"The study of production, however, is not only a meeting place, but is slowly emerging as a science in its own right. As such, it demands research which is production-centred and not merely the result of secondary or marginal interests of economists of engineers, of mathematicians or psychologists, indispensable and invaluable though their contributions are. Thus, the principal intention of this Journal is to provide a vehicle for the publications of those university and other research workers whose primary interest is in advancing the science of production, and for whom, until now, there has been no single and appropriate Journal.

"There is a general tendency for advanced scientific research to become progressively more specialised and isolated. In the field of production, however, research began in a piecemeal fashion — spasmodic and unco-ordinated — the divisions accentuated by a confusing array of scientific and technical jargons.

"It is hoped that, in satisfying the need expressed by a number of university and industrial research workers for an international forum for the publication and discussion of research findings relating to production, this new Journal will create a unifying and stimulating influence. It will embrace all aspects of production — production policy, planning and control, industrial skills, productivity measurement and production processes in all technologies. It will comprise original reports by university and industrial research workers for the benefit of other research workers and of university and college lecturers through whom is offered, albeit indirectly, a contribution to the efficiency of industrial production."

SHEFFIELD SECTION DINNER

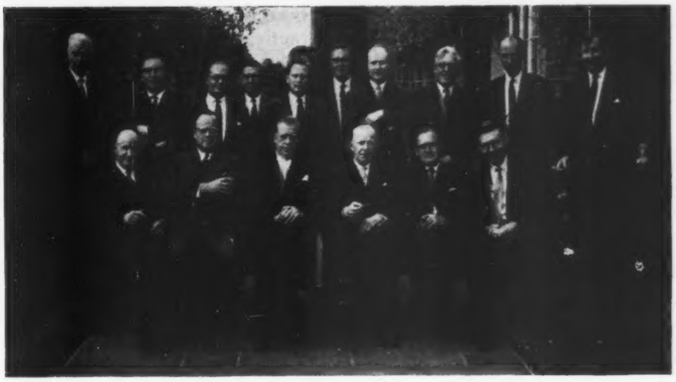
The Sheffield Section Annual Dinner, which was held at the Grand Hotel, Sheffield, on 9th October last, was graced by a number of prominent guests, photographed here with their hosts. Front row (left to right): **The Master Cutler, Mr. Gerard Young; Mr. Eric Mensforth, C.B.E.; The Lord Mayor of Sheffield, Alderman J. W. Sterland; Mr. J. G. Noble, Sheffield Section Chairman; the Institution President, Mr. Harold Burke; Mr. H. A. Mcnab.** Second row (left to right): **Mr. C. L. David, Leeds Section Chairman; Mr. G. Butler, Halifax and Huddersfield Section Chairman; Mr. John Snow; Mr. W. A. Hannaby, East and West Ridings Regional Chairman; Mr. D. A. Senior.** Rear (from left to right): **Mr. H. Steel; Mr. John Baker, Doncaster Section Chairman.**

MIDLANDS REGION WORKS VISIT

The Midlands Region Committee commenced the current session's activities with an informal luncheon at the works of James Archdale & Co. Ltd., Worcester, on 22nd August, when they were received by Mr. D. E. Graham, Managing Director, and Mr. M. Froggatt, Managing Director of Staveley Industries Ltd.

After luncheon the party, which was representative of most Sections within the Region, was conducted round the works and saw examples of the latest developments in construction and design which are being applied to the Company's range of standard and special machine tools.

The Committee expressed their appreciation for this opportunity; it is felt that the Company's interest will do much to encourage the Midland Region's efforts to promote production engineering in future industrial development in the area.



Members of the Midlands Region Committee photographed with their hosts during their visit. Front row (left to right): **Mr. E. P. Edwards; Mr. D. E. Graham; Mr. T. W. Elkington, Regional Chairman; Mr. M. Froggatt; Mr. H. Tomlinson; and Mr. A. C. Turner, Regional Honorary Secretary.**

ALL-INDIAN CAREER CONFERENCE

The Chairman of the Institution's Bombay Section, **Mr. Alec Miller,** was a speaker at a recent "Career Conference" organised by the All-India Manufacturers Organisation, and held in the auditorium of the Sydenham College of Commerce and Economics, Bombay.

The majority of the addresses given were concerned with India's Third Plan, and the requirements of engineers, universities, colleges and courses. Mr. Miller addressed his remarks to young men and women about to choose a career; in describing production engineering he said:

"At the period of one's life when a decision has to be made on how to utilise one's talents, one is influenced by environment, family tradition, and by friends, but there is always an inclination towards the glamorous. In the present day it is space rockets — atomic energy and jet aircraft are now losing popularity.

scientists depend on production engineers

"In various countries scientists have evolved these glamour items, but they never make them. If we check in percentages the number of scientists employed on these projects, in world figures it is minute, but the men who have to put these ideas into feasible working order are production engineers. Without them, a rocket could not be made and an atomic power station could not have materialised. Even now all the scientists' experiments depend on the production engineers.

"So much for glamour! What about motor cars, engines, aeroplanes — every article you use, every machine built to manufacture any article — they all come from the hands of production engineers. Unlike the scientists we are not in small numbers; we are in tens of thousands and we are still far too few. Every future is fascinating, particularly in India. Every production engineer is endeavouring to produce more at a lower selling price, to improve designs, to simplify designs to make the ordinary things in life available to everyone, so that none may envy his neighbour—this is in itself an inspiration and a goal well worth aiming for.

many opportunities

"The opportunities are many, but the way is not easy. When you become an experienced production engineer you enter an International Club, for from whatever country come the drawings of any machinery, article or tool, no matter what the language—it can be read with ease. When engineers meet on a production problem, whether their native tongue be Japanese, Chinese, Hindi, Russian, Czechoslovakian, Rumanian, French, Italian or English—they can converse, for pencil, paper and engineering knowledge cover all grounds. Countries and their varied politics and principles are brought to a common level—production engineering is the doorway to travel, friendship and understanding.

"When you leave college with a diploma or a degree, you are just knocking at the door of oppor-

tunity. If the door at which you knock is marked "Production Engineer", then I must warn you that the first steps are difficult. You must become adept on many machines and achieve a practical working knowledge of many processes—this may take a few or a number of years, but it is the foundation of your future.

"The knowledge is now applied to improve what is already available—to produce more, not by making men work harder, but by eliminating waste of time and materials. Your skill will make the machines do more work; you will redesign for better production. You will replan a factory, or perhaps lay out a new factory, and as a production engineer you will do this so that men work in rhythm and comfort, and maintain the flow of work. The satisfaction of the men and staff will be your reward.

"Beginning with small projects, the tasks will improve in magnitude as experience is gained—each one a challenge, each one of absorbing interest—until perhaps you are called upon to travel to other countries. If you have learned well, you are received as an honoured colleague and guest all over the world.

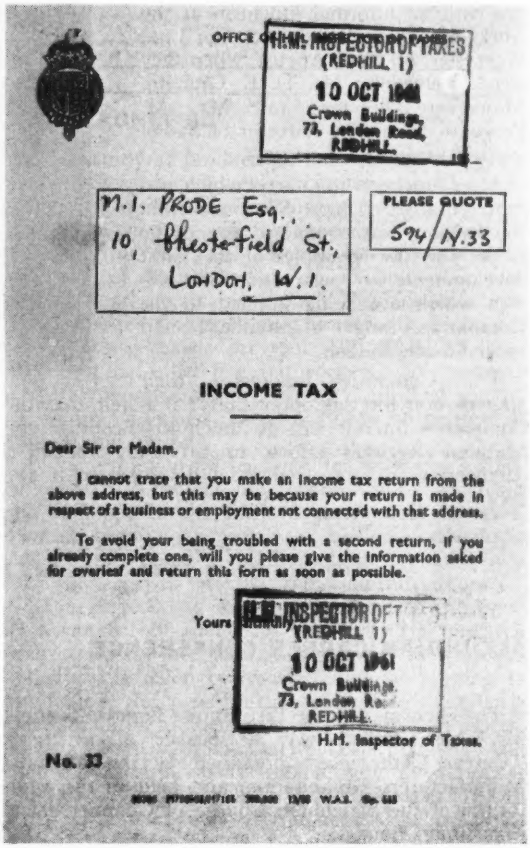
"In the production engineer's life, each task, small or large, simple or complex, brings its own reward on completion. Each brings him a step higher on the ladder of success until he can be judged in a paraphrase of Kipling's poem:

'If you can fill the unforgiving minute
With sixty seconds' worth of distance run,
Yours is the earth and everything that's in it,
What's more, you'll be a production engineer,
[my son!'"

COVENTRY SECTION DINNER

A happy photograph taken at the Coventry Section Dinner held on 4th October last. The President of the Institution, with Mrs. Burke (on the left) with the Section Chairman, Mr. William Core and Mrs. Core.

CAN ANY MEMBER HELP?



OFFICE OF H.M. INSPECTOR OF TAXES
(REDHILL 1)
10 OCT 1961
Crown Buildings,
73, London Road,
REDHILL.

N.I. PRODE Esq.,
10, Chesterfield St.,
LONDON, W.1.

PLEASE QUOTE
594/N.33

INCOME TAX

Dear Sir or Madam,

I cannot trace that you make an Income tax return from the above address, but this may be because your return is made in respect of a business or employment not connected with that address.

To avoid your being troubled with a second return, if you already complete one, will you please give the information asked for overleaf and return this form as soon as possible.

Yours faithfully,

H.M. INSPECTOR OF TAXES
(REDHILL 1)
10 OCT 1961
Crown Buildings,
73, London Road,
REDHILL.

H.M. Inspector of Taxes.

No. 33

The above communication was recently received at Headquarters. If any member can assist in tracing Mr. Prode, whose name does not appear in the membership index, the Secretary would be pleased to receive any information.

CHRISTMAS HOLIDAY

The Headquarters' offices of the Institution will be closed from **5 p.m., Friday, 22nd December** until **Thursday, 28th December.**

NEWS OF MEMBERS

Dr. W. O. Alexander, Member, Assistant Research Manager of Imperial Chemical Industries, Metals Division, has been appointed Technical Director of Foseco International, a subsidiary of Minerals Separation.

Mr. R. Appleby, Member, Executive Vice-President, European Operations, Black & Decker Ltd., is now President of the Board of Star Utensili Electrici S.P.A. Italy, of the Black & Decker Group. Mr. Appleby takes this office in addition to his present duties.

Mr. L. W. Bailey, Member, representing The British Institute of Management, has been elected Chairman of the National Joint Committee on Materials Handling. He is Chairman of the Institution's London Section Materials Handling Group, a member of the Research and Technical Committee, and Chairman of the Computers and Production Control Sub-Committee.

Mr. S. Carroll, Member, has been appointed a Production Engineer on the Corporate Management staff of Massey-Ferguson Ltd., Manufacturing Division, Toronto, Canada.

Mr. R. J. Evans, Member, has relinquished his appointment as Head of the Department of Engineering, Burnley Municipal College, and is now Head of Department of Mechanical Engineering, Wolverhampton and Staffordshire College of Technology, Wolverhampton.

Mr. A. C. Main, Member, has been appointed Director of Manufacturing Services of Associated Electrical Industries. He remains as a non-executive Director on the Board of A.E.I. (Manchester) Ltd.

Mr. R. G. Monkhouse, Member, Manager of the Central Engineering Workshops at The United Steel Companies' Workington Iron and Steel Co. branch, has been appointed Works Manager (Ickles) at the Steel, Peech & Tozer branch.

Sir William Scott, O.B.E., J.P., Member, has been nominated to represent the Newcastle upon Tyne Section on the Governing Body for Gateshead Technical College. Sir William Scott is Chairman of the Section.

Mr. W. Thompson, Member, has been appointed Chairman of the Board of Directors of Peter Brotherhood Ltd. He has been with the Company for 47 years and was appointed Works Director three years ago.

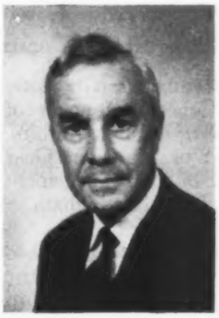
Mr. Alfred G. Weller, Member, is retiring as Secretary of the Nottingham Society of Engineers, a position he has held for the past 31 years. He is Chairman and Managing Director of the Weller Gauge and Welding Co., Bilborough, and a director of other companies. He was recently appointed a Governor of the People's College of Further Education.

Mr. R. D. Baines, Associate Member, has been appointed Works Manager of Crofts Engineers (SA) (Pty.) Ltd., Transvaal, South Africa.

Mr. P. Binks, Associate Member, has relinquished his position with Lightning Fasteners at I.C.I. Ltd., Metals Division, Witton, and has taken up an appointment with The Titanium Plant, also at I.C.I. Ltd., as Experimental Officer in the Production Department.

Mr. J. A. Burton, Associate Member, has been appointed Lecturer at the Harris College, Preston.

Mr. H. J. Cheston, Associate Member, has been appointed Production and Contracts Engineer, C.M. & E.E. Department, Eastern Region, British Railways, Doncaster.



Mr. S. Davis, Associate Member, has been appointed a Director of the Backer Electric Co. Ltd., Rotherham. He joined the Company in 1938, and became Works Manager in 1953.

Mr. D. G. Galpin, Associate Member, is responsible for the newly opened London Office of Ina Needle Bearings of Llanelly, which will serve the London area, South and South-West England.

Mr. N. Herbert, Associate Member, has taken up an appointment as Head of Department Engineering Trades at The David Dale College, Glasgow. He was previously at the College of Technology, Chesterfield.

Mr. E. J. Granger, Associate Member, is now Managing Director of C. S. du Mont Ltd., Sheerwater, Woking.

Mr. J. F. Hedley, Associate Member, has relinquished his position as a Planning Engineer with Bristol Siddeley Engines Ltd., Sunderland, and has taken up an appointment as Assistant Lecturer Grade B at the West Park College, Sunderland.

Mr. W. H. Holmes, Associate Member, Managing Director of M.T.E. Control Gear Ltd., Leigh-on-Sea, Essex, recently left London for an extensive tour of Adelaide, Australia, New Zealand and Canada.

Mr. G. N. Iley, Associate Member, has been appointed Deputy to Director of Supplies, The British Motor Corporation Ltd., Longbridge, Birmingham.

Mr. B. W. James, Associate Member, has relinquished his position as Chief Project Engineer with de Havilland Aircraft Co. Ltd., Hatfield, and has taken up an appointment as Production Engineer with Hunting Aircraft Ltd., Luton.

Mr. C. A. Lewis, Associate Member, has been appointed Technical Consultant to G. & R. Gilbert (Industrial) Ltd., Hackbridge, Surrey.

Mr. A. H. Mills, Associate Member, has joined the Board of Jessop-Saville (Small Tools) as Sales Director.

Mr. R. P. Pike, Associate Member, has taken up an appointment as Apprentice Supervisor with Fairey Engineering Ltd., Hounslow, Middlesex.

Mr. W. A. Powell, Associate Member, has recently taken up an appointment as General Manager of Suflex Ltd., Risca, near Newport, Monmouthshire, having relinquished his position of Manager, Gear Design Department and member of the Management Group with Raleigh Industries Ltd., Nottingham.

Mr. F. G. Russell, Associate Member, has relinquished his position with Phoenix Telephone & Electric Works Ltd., Hendon, and has taken up an appointment with English Electric Aviation Ltd., Luton, as Senior Methods Engineer in the Production Engineering Group.

Mr. O. J. Swannie, Associate Member, has relinquished his position with R.F.D. Co. Ltd., as Manager of their Engineering Department, and has taken up a new appointment as Senior Consultant with Industrial Consultants, Milan, Italy.

Mr. S. J. Sterrett, Associate Member, has relinquished his position with the Medical Research Council and has taken up an appointment with English Electric Aviation Ltd., Instrument Wing, Stevenage, Herts.

Mr. C. V. Dolphin, Associate, has relinquished his position with Wilmot Breeden Ltd. to take up an appointment as General Manager to Midland Aerosols Ltd. and Speciality Valves Ltd.

Mr. M. J. Berry, Graduate, has been appointed Production Controller, Advanced Design Division of Unbrako Socket Screw Co. Ltd., Coventry.

Mr. S. Black, Graduate, has taken up an appointment for training in Production Management for a period of two years with the Singer Sewing Machine Manufacturing Co., at their factory in France.

Mr. P. Brown, Graduate, has taken up an appointment as Project Engineer with M. B. Wild & Co., Ltd., Nechells, Birmingham. He was formerly with Sir W. G. Armstrong Whitworth Aircraft Ltd.

Mr. K. G. Hillman, Graduate, has relinquished his appointment as Production Controller with Wallace & Tiernan Ltd., Tonbridge, Kent, and is now Technical Services Manager with Mansell Hunt Catty & Co. Ltd., London.

Mr. D. Percy, Graduate, has taken up an appointment with Findlay, Irvine Ltd., Edinburgh. He was formerly Project Engineer with Ferranti Ltd., Edinburgh.

Mr. M. H. Pherwani, Graduate, has successfully completed two one-year post-graduate diploma courses in Industrial Management and Production Engineering at Manchester University and Imperial College, London, respectively, and has taken up an appointment as an Assistant Works Manager with Larsen & Toubro Ltd., Bombay. Mr. Pherwani was in the United Kingdom on a two-year scholarship awarded to him by the Assam Oil Company.

Mr. A. Rice, Graduate, has recently completed his post-graduate course in Production Engineering at Imperial College, London, and has taken up a position as Assistant to the Production Controller at the Acton Works of Napier Aero Engines Ltd.

Mr. J. W. Richings, Graduate, has relinquished his position as Chief Production Study Engineer at Sanlinea Industrial Services, Cardiff, and has taken up an appointment as Work Study Engineer at S. Smiths & Sons (England) Ltd., Witney, Oxon.

Mr. H. R. Robinson, Graduate, has relinquished his position as General Manager with the Brehmer Folding Box Co. Ltd., and has taken up an appointment as Executive Works Director with Farrey & Daisley Ltd., Oldham.

Mr. B. J. Smith, Graduate, is now a Work Study Engineer with Kodak Ltd., Stevenage.

Mr. A. E. Veness, Graduate, has taken up an appointment as Senior Planning Engineer with Bristol Aircraft Ltd.

Mr. V. C. White, Graduate, who was formerly a Senior Steam Turbine Estimating Engineer at Belliss

& Morcom Ltd., Birmingham, is now an Atomic Power Engineer at the English Electric Co., Whetstone, near Leicester.

Mr. D. E. Whittles, Graduate, has relinquished his appointment with the Crawley College of Further Education, and has taken up an appointment as Lecturer in the Mechanical Engineering Department of the Borough Polytechnic, London.

Mr. R. M. Wilkinson, Graduate, has relinquished his position as a Work Study Engineer with G.E.C.-Osram Lamp Division, Lancs., and has taken up an appointment with the Falkland Island Dependencies Survey in Antarctica, for a period of two years.

Mr. A. T. Yates, Graduate, has now taken up an appointment as Personal Assistant to the Works Manager at Birmid Auto Castings (Pty.) Ltd., Victoria, Australia.

DIARY FOR 1962

JANUARY 25 ... ... **Annual General Meeting of the Institution.**
10 Chesterfield Street, Mayfair, London, W.1.

MARCH 28 ... ... **The 1961 George Bray Memorial Lecture**
at the **University of Birmingham.**
Speaker : **Mr. J. F. Stirling,** Executive Technical Director, James A. Jobling & Co. Ltd.
Subject : **The Production of Industrial and Domestic Glassware.**

APRIL 5-7 ... ... **Aircraft Production Conference, College of Aeronautics, Cranfield.**
Theme : **Building Aircraft for the Competitive World Market.**

MAY 15 and 16 ... ... **Eighth Annual Conference of Engineers Responsible for Standards.**
The Connaught Rooms, London.

BINDERS FOR "THE PRODUCTION ENGINEER"

The Institution is able to supply the "Easibind" type of binder, in which metal rods and wires hold the issues in place, and which is designed to hold six issues.

It will be found that copies of "The Production Engineer" can be quickly and simply inserted into this binder, without damage to the pages, and that binding six issues at a time, instead of twelve, will facilitate easier reference and handling of the volumes.

The binders may be obtained from: The Publications Department, 10 Chesterfield Street, Mayfair, London, W.1, price 10/6 each, including postage. Date transfers, for application to the spine of the binder, can be supplied if required, price 6d. each. (Please specify the year required.)

ELECTIONS AND TRANSFERS

approved at the Meeting of the Council of the Institution

26th October, 1961

BANGALORE SECTION

As Student
B. N. Gupta.

BIRMINGHAM SECTION

As Associate Members
R. H. Spikes; K. G. Walton.
As Graduates
J. D. Barrons; A. H. Green; V. S. Cornock; K. A. Hill; J. B. Payne.
As Student
P. M. Cornish.
Transfers
From Associate Member to Member
W. Hamilton.
From Graduate to Associate Member
S. H. Watson.
From Students to Graduates
G. Massey; K. A. Brookes; M. S. Woolston.

BOMBAY SECTION

As Associate Member
V. R. Pawar.
As Graduates
H. K. Ballal; A. K. Mukhopadhyay.
As Students
K. Chathapuram Narayanaswami; J. J. Mehta.

CALCUTTA SECTION

As Associate Members
B. C. Rath; V. Jambunathan.
As Graduates
S. K. Bandopadhyay; A. C. Bhattacharya; S. P. Sinha.
As Students
A. K. Banerji; V. K. Khanna; R. P. Joneja.
Transfer
From Graduate to Associate Member
D. M. Gupta.

CARDIFF SECTION

As Graduate
L. T. E. Dex.
As Student
D. C. Davies.
Transfers
From Graduate to Associate Member
D Williams.
From Student to Graduate
A. T. Joslin.

COVENTRY SECTION

As Associate Member
C. E. T. Smith.
As Graduates
G. Havard; M. W. Greaves; A. J. Draper; R. K. Watkins; R. J. Pickersgill; G. G. Edwards; W. G. Lamb; T. A. Ashby; I. G. Inglis; J. B. Hayes.
As Students
G. H. Oliver; R. J. P. Story.
Transfer
From Student to Graduate
R. G. Bradley.

DERBY SECTION

As Associate Member
A. Briggs.
As Graduates
P. J. Bull; T. Taylor.
Transfer
From Associate Member to Member
P. Warburton.

DUNDEE SECTION

Transfer
From Graduate to Associate Member
M. J. Walsh.

EDINBURGH SECTION

As Graduate
E. R. Cowan.
Transfer
From Graduate to Associate Member
W. J. Brown.

GLASGOW SECTION

As Associate Member
J. Moohan.
As Graduates
N. Trotter; A. Lal; G. I. Christie; W. C. D. Davidson; J. Horn; J. Y. Russell; J. D. Boyd; A. K. Basu; M. C. Martin.
As Students
A. Mincher; F. Thomson; J. D. Millar; G. L. Edwards; A. K. MacAllan; W. Reid.
Transfers
From Graduates to Associate Members
R. A. Mitchell; D. McWhinnie; B. E. Collier.
From Students to Graduates
H. M. Whitelaw; A. MacR. Borland; A. Taylor.

GLOUCESTER SECTION

As Student
N. F. Vetch.
Transfer
From Graduate to Associate Member
L. Powell.

HALIFAX/HUDDERSFIELD SECTION

Transfer
From Graduate to Associate Member
C. Jaikens.

IPSWICH & COLCHESTER SECTION

As Associate Members
R. C. Carter; M. Drinkall.
As Graduate
R R. J. Baker.
As Student
M. A. Freeman.
Transfers
From Graduate to Associate Member
M. D. Blake.
From Student to Graduate
J. B. Bartholomew.

LEEDS SECTION

As Associate Members
T. S. Vaseer; V. Chapman; H. P. Hinde; S. Wheeler.
As Graduates
G. White; E. Brassington.
As Students
J. T. Hindle; D. R. Halstead.
Transfer
From Graduate to Associate Member
M. Barker.

LEICESTER SECTION

As Associate Member
A. E. Williams.
As Graduates
J. Yardley; K. J. Leech.
As Students
H. Haythornthwaite; B. G. Bryan; D. J. Nunn.
Transfer
From Associate Member to Member
F. A. Mee.

LINCOLN SECTION

As Graduates
P. F. Towning; F. A. Heal.
Transfer
From Graduate to Associate Member
J. M. Wood.

LIVERPOOL SECTION

As Associate Member
J. I. Cameron.
As Graduates
P. M. Organ; E. Byrne; R. L. Rosbotham.
As Student
W. A. Hughes.
Transfers
From Associate Member to Member
E. Walshaw.
From Student to Graduate
J. Roberts.

LONDON SECTION

As Member
F. L. S. Gunner.
As Associate Members
R. L. Thring; D. I. Speirs; J. M. Rogerson; D. Pearson; J. D. Noble; J. A. Napper; D. W. Hammond; E. C. Fletcher; J. I. Graham; C. J. Gregory; C. F. Ackerman; D. H. Bailey; D. H. Russell.
As Associate
I. J. Thomas.
As Graduates
K. J. Hill; K. W. Hards; R. N. Khandelwal; F. W. Iselin; J. W. Wells; S. L. O. Ojekwe; G. F. N. Miller; D A. Archer; J. E. Wicks; J. D. Knuckey; J. B. Cooper-Keeble; P. D. Smith; K. J. Smith; R. C. Skelton; T. E. O. Thorpe; S. Gafney; T. Kovacs; M. S. Blazey; D. L. C. Bebbington; P. G. Edkins.
As Students
I. D. Moodie; T. A. Green; R. A. J. Burrows.
Transfers
From Associate Members to Members
L. Landon Goodman; F. J. Willmott.
From Graduates to Associate Members
D. A. Luff; R. H. Dodgson; A. W. J. Pullen; M. W. G. Lewis; A. R. Stevens; S. R. Freeman; R. D. Sweet; R. E. Puttick; M. S. Davis; L. E. Fishburn; L. J. Martin.
From Graduate to Associate
R. F. Popperwell.
From Students to Graduates
G. Birchmore; K. J. Stevings; P. C. Matthews; A. R. Adams; P. J. Waters; M. T. W. Toulson; P. D. Toulouse; S. R. Tomlin; R. Coupar; A. E. R. Grubb; D. Robinson.

LUTON SECTION

As Associate Member
A. C. Clark.
As Graduates
P. J. Edwards; R. W. Ashton; R. G. Arnold; A. Gordon; D. M. de Groot.
As Students
N. K. Smith; R. S. Gentle.
Transfer
From Graduate to Associate Member
C. Halton.

MANCHESTER SECTION

As Associate Members
K. G. McMinn; R. B. Russell.
As Associate
J. R. Henshaw.
As Graduates
S. M. Patel; H. C. Dent; B. I. Patel; G. Bradley; J. Yabsley.
As Student
D. W. Heap.

MELBOURNE SECTION

As Graduates
P. W. Meyers; W. G. J. Broomhead; J. A. Gillespie, G. Arndt; E. Bonollo.
As Students
K. R. Johns; K. E. Miller.
Transfer
From Student to Graduate
G A. Jennings.

NEWCASTLE-upon-TYNE SECTION

As Associate Members
J. Morton; D. V. Lampard.
As Graduate Member
E. Martin.
As Students
C. S. Jackson; P. J. Fleming.
Transfers
From Students to Graduates
B. J. Parry; A. Howe.

NEW ZEALAND SECTION

As Associate
E. V. Forsey.

NORWICH SECTION

As Associate Member
D. J. Truscott.

NOTTINGHAM SECTION

As Member
H. K. Pritchard.
As Graduate
J. R. Bostock.

OXFORD SECTION

As Member
K. W. T. Edwards.
Transfers
From Associate Member to Member
R. W. Hillyer.
From Graduate to Associate Member
F R. Funnell.

PETERBOROUGH SECTION

As Member
F. E. Collis.
Transfer
From Associate Member to Member
N. Holmes.

PRESTON SECTION

As Associate Members
G. Norris; H. Marshall.
As Graduates
B. Hughes; F. T. Mercer; D. Haslam; G. Wright.
As Students
K Gururaj; J. B. Greenwood.

Transfers
From Graduate to Associate Member
W. J. White.
From Students to Graduates
P. Joinson; F. K. Bryce.

READING SECTION

As Graduates
D. S. Kingsley; L. T. Kwan; F. L. Brown; N. J. C. Smith.
As Student
P. G. Burgess.
Transfers
From Graduates to Associate Members
L. J. Lambourne; M. J. Inston; J. M. Barber.

ROCHESTER SECTION

As Graduate
A. G. Poppe.
As Student
A. C. Towlson.

SHEFFIELD SECTION

As Associate Members
K. H. Sutherland; K. Swann; F. G. Varah.
As Graduate
M. D. Baxter.

SHREWSBURY SECTION

Transfer
From Student to Graduate
P. G. Hibberd.

SOUTHAMPTON SECTION

Transfer
From Student to Graduate
J. N. Stevens.

SOUTH AFRICA SECTION

As Associate Members
G. T. W. Wingrove; P. W. Tyler.
As Associate
A. W. Liell-Cock.
As Graduates
H. L. Aucamp; S. K. Mukerjee; R. D. Rehr.

SOUTH ESSEX SECTION

As Associate Members
R. L. Clarke; V. A. J. Gifford.
As Graduates
G. D. Swabey; J. D. Lovett; G. Williams.
As Students
A. R. Bowdon; A. C. W. Maxwell; J. C. Parish.
Transfers
From Students to Graduates
D. A. Paterson; G. J. Bennett.

SWANSEA SECTION

As Member
S. Dowling.
As Graduate
E. J. Harry.
As Student
P. P. Edwards.
Transfers
From Graduate to Associate Member
W. M. G. Evans.
From Student to Graduate
V. J. Borsden.

SYDNEY SECTION

As Member
R. S. Thompson.
As Associate Member
J. H. P. Austin.
As Graduates
C W. Eldridge; M. M. Rudolph.

As Students
K. Boyd; A. E. Inglis; R. Whetton; L. Reynolds.
Transfer
From Associate Member to Member
J. F. Wilkie.

TEES-SIDE SECTION

As Associate Member
J. W. Carr.

WESTERN SECTION

As Associate Member
E. K. Ham.
As Associate
P. Bradley.
As Students
D. A. Sturgess; B. C. F. Serjent.
Transfers
From Associate Members to Members
J. E. Morris; J. Glennie.
From Graduate to Associate Member
E. R. S. Marrs.
From Student to Graduate
R. B. A. Dyer.

WOLVERHAMPTON SECTION

As Members
A. H. McIlreath; N. Walker; J. C. Abberley.
As Associate Member
J. A. Abrahams.
As Graduates
D. S. Minocha; S. C. Humphreys; J. B. Green; J. H. Allen; A. Humpage; B. R. W. Fowler; T. Grange.
As Student
W. J. Weston.
Transfers
From Associate Member to Member
A. S. Sault.
From Graduates to Associate Members
G. Washbrook; A. F. Poole.
From Students to Graduates
B Jones; J. D. Alton; P. J. Forrest; B. Timmis; A. A. Allen; R. L. Richards.

WORCESTER SECTION

As Student
R. G. Hewitt.
Transfers
From Associate Members to Members
J Morris; R. D. Turner.
From Graduate to Associate Member
K R. Matthews.
From Student to Graduate
N. O. Rose.

NO SECTION

As Members
A. W. Crombie; J. S. P. Phillips.
As Associate Members
N. Steiner; S. H. Shah; G. Z. Khan.
As Graduate
R. B. C. Elliott.
As Student
M. S. Ngai.
Transfers
From Graduate to Associate Member
J. D. Wiseman.
From Students to Graduates
D. J. Dallaway; G. S. Grewal.

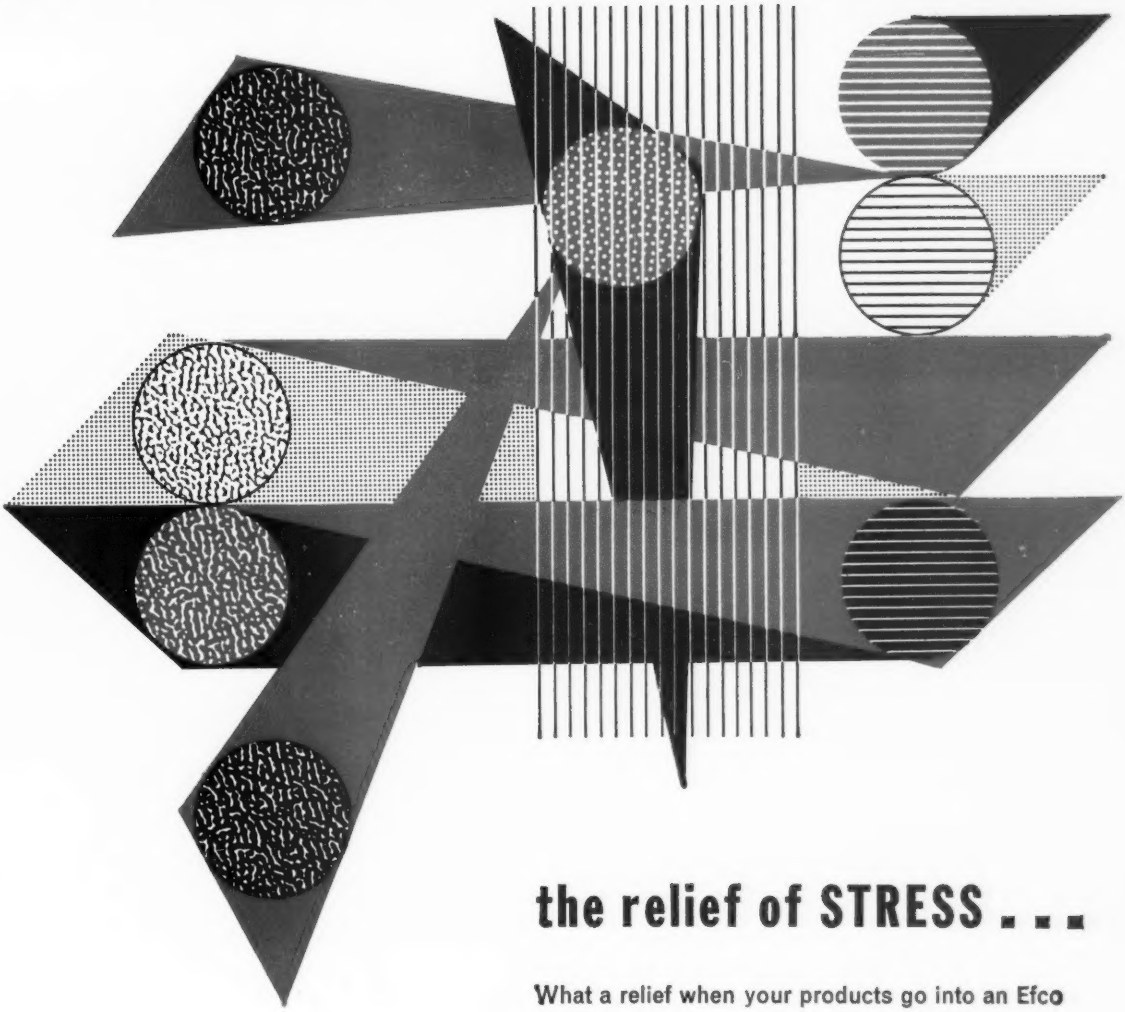
MEMBERS TRAVELLING OVERSEAS

United Kingdom members of the Institution are always welcome guests to overseas Sections and the Secretary of the Institution will be pleased to provide letters of introduction to any United Kingdom members visiting other parts of the Commonwealth.

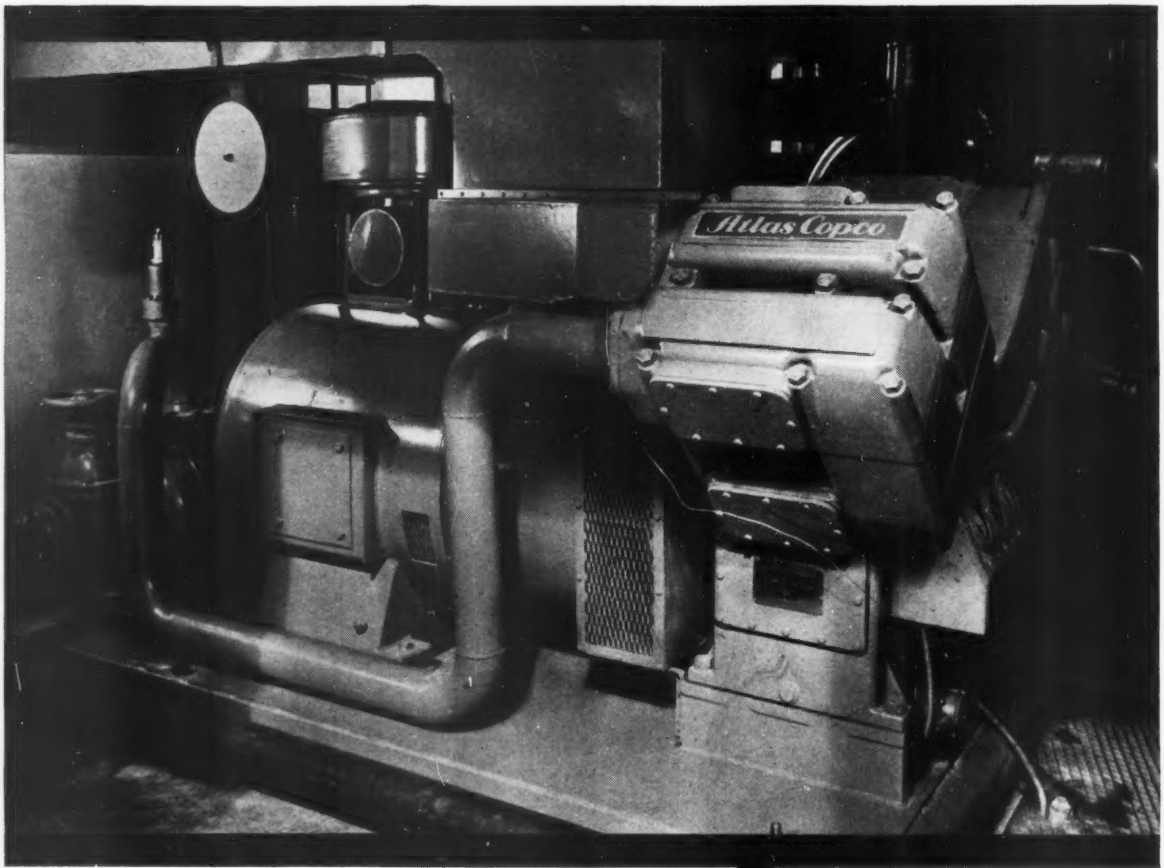
Journal Contents

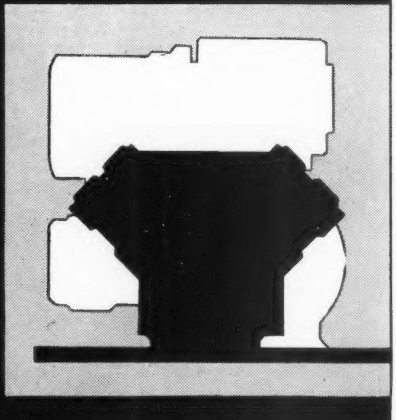
Volume 40, 1961

Subject Index to Papers Published, 1961



RIGHT FROM THE WORD 'GO' . . .





S/213

. . . the DT4 compressor looks after itself

Here's a compressor you can install—and then forget about. Suitable for 24 hours a day continuous operation.

The DT4 delivers 565 cfm, and is a fully air-cooled, short-stroke, two-stage machine. Weighing 2,200 lb, it occupies 30-50% less space than most compressors of similar capacity. No special base is needed, it can be fitted with a frame mounting and rubber feet, thus enabling it to be moved from place to place. The DT4's compact design allows easy passage through mine shafts, drifts and similar places. It is an ideal compressor for mining and contracting work.

Important Space Savings

The economy in space offered by the Atlas Copco DT4 is convincingly demonstrated by the silhouette of a DT4 (shown right) superimposed on the outline of a conventional compressor of equal capacity.

For further information on the DT4, write for a copy of leaflet E1208. It is readily available from your local Atlas Copco branch or from the address below.

ATLAS COPCO (GREAT BRITAIN) LIMITED
Maylands Avenue, Hemel Hempstead, Herts. Tel: Boxmoor 6040
Sales and service depots: LONDON · BRISTOL · CARDIFF · LICHFIELD · LEEDS
MANCHESTER · NEWCASTLE · GLASGOW · BELFAST · DUBLIN

Atlas Copco

puts compressed air
to work for the world

The Council of the Institution

1961/1962

President
Harold Burke

Vice-President
R. Ratcliffe, C.B., M.B.E.

Chairman of Council
R. H. S. Turner

Vice-Chairman of Council
A. L. Stuchbery

Immediate Past Chairman of Council
H. W. Bowen, O.B.E.

Past Presidents
Major-General K. C. Appleyard, C.B.E. Sir George Bailey, C.B.E. The Rt. Hon. the Earl of Halsbury E. W. Hancock, O.B.E. Sir Leonard Lord, K.B.E. The Rt. Hon. Viscount Nuffield, C.H., G.B.E. G. Ronald Pryor Sir Walter Puckey Norman Rowbotham, C.B.E. J. D. Scaife Dr. H. Schofield, C.B.E. The Rt. Hon. the Lord Sempill, A.F.C.

Presidents of Councils outside the United Kingdom
Australian Council — I. M. McLennan, C.B.E.
Indian Council — S. L. Kirloskar
South African Council — E. H. Dallas

Chairmen of Regional Committees

East & West Ridings
W. A. Hannaby
Eastern
G. S. Howell
Midlands
T. W. Elkington
North Midlands
E. Steele

Northern
A. Cameron
North Western
H. G. Gregory
Northern Ireland
T. S. G. Kee
Scotland
H W. Townsend

South Eastern
W. Robinson
Southern
C. Sumner
South Western
F. G. C. Sandiford
Wales
W. H. Bowman

Additional Representatives on Council

East & West Ridings
E. Levesley
Midlands
E. P. Edwards

North Western
R. S. Clark
South Eastern
G. Kelly

Chairmen of Standing Committees
John M. Brice (*Editorial*) R. M. Evans (*Research & Technical*) J. C. Z. Martin (*Papers*) R. V. Rider (*Library*) J. A. W. Styles (*Education*) H. Stafford (*Standards*) Dr. T. U. Matthew (*Membership*)

Elected Members
G. V. B. Bevan G. R. Blakely A. Betts Brown A. G. Clark W. Core C. E. Darlington E. S. Hammett R. W. Hancock P. G. H. Jeffrey R. E. Leakey J. G. Noble G. C. Oram C. Phillips P. J. Shipton L. P. Simpson J. W. H. Smith J. P. Speakman J. H. Winskill

Chairmen of Sections outside the United Kingdom where Councils are not established

Canada
S. Carroll

New Zealand
J. C. Fantham

Overseas Councils

AUSTRALIA

President
I. M. McLennan, C.B.E.

Chairman
N. L. Eaton

Immediate Past President J. M. Steer
Past Presidents W. Gwinnett, J. N. Kirby
Vice-Chairman R. W. Deutsher
Honorary Secretary J. M. Steer
Honorary Treasurer K. G. Slorach

Delegates
H. J. Baker H. A. Colton B. H. Coombes C. S. Curtis S. Downie E. J. W. Herbert C. A. Gladman
R. Harris A. G. Jones A. E. Newcombe A. Pead F. W. Penny C. Pullen K. H. Shute L. W. Worthington

INDIA

President S. L. Kirloskar
Vice-President Air Vice-Marshal Harjinder Singh, M.B.E.

Chairman T. R. Gupta
Vice-Chairman A. Miller
Honorary Secretary P. J. O'Leary
Honorary Treasurer H. N. Ghosal

Section Representatives
P. Bhattacharji N. G. Chakravarty S. R. Chatterjee C. H. DeSousa B. F. Goodchild N. N. Sen Gupta C. K. Haldar
W. P. Karnick G. L. Lewis R. A. P. Misra R. D. Mistry C. R Pal J. V. Patel R. N. Rai J. W. L. Russell E. W. H. Scaife
B. M. Sen P. V. Shah S. J. Shahany

SOUTH AFRICA

1st Vice-President R. Young
2nd Vice-President R. W. Chapple
Immediate Past President G. G. Tardrew
President E. H. Dallas

Past Presidents
R. H. Arbuckle D. N. S. Clare W. G. Gillespie H. J. G. Goyns D. E. Hamm J. Henry T. H. Hunter
D. Lion-Cachet C. J. Mogford J. Renwick

Elected Members
A. B. Anderson A. B. Astrup P. C. Ellett R. A. Heugh D. A. Horton G. K. Melvill P. R. Pemberton D. A. Petrie
G. M. Tompkins H. Veit M. E. Walsh

SECTION CHAIRMEN

R. Harris .... *Adelaide*
S. M. Patil .... *Bangalore*
Dr. T. U. Matthew .... *Birmingham*
A. Miller .... *Bombay*
N. N. Sen Gupta .... *Calcutta*
S. Carroll .... *Canada*
G. R. Faulks .... *Cardiff*
K. Farnell .... *Cornwall*
W. Core .... *Coventry*
H. L. Barman .... *Derby*
J. Baker .... *Doncaster*
J. N. Low .... *Dundee*
F. H. Eccersley .... *Edinburgh*
H. W. Townsend .... *Glasgow*
N. S. Payne .... *Gloucester*
G. Butler .... *Halifax & Huddersfield*
R. V. Taylor .... *Ipswich & Colchester*
C. L. David .... *Leeds*
J. H. Devonald .... *Leicester*
R. Preston .... *Lincoln*
E. Walshaw .... *Liverpool*
R. Hutcheson .... *London*
J. Cherry .... *Luton*
J. D. W. Taylor .... *Manchester*
R. W. Deutsher .... *Melbourne*
L. L. Gonda .... *Montreal*
Sir William Scott, O.B.E., J.P. .... *Newcastle upon Tyne*
J. C. Fantham .... *New Zealand*
T. S. G. Kee .... *Northern Ireland*
C. W. Maddison .... *Norwich*
C. H. Hodgkins .... *Nottingham*
F. S. Chappell .... *Oxford*
E. Steele .... *Peterborough*
H. A. Kench .... *Preston*
L. J. Service .... *Reading*
R. Bradford .... *Rochester*
J. G. Noble .... *Sheffield*
G. Deane .... *Shrewsbury*
E. H. Dallas .... *South Africa*
C. Sumner .... *Southampton*
S. R. Trevillion .... *South Essex*
T. Proctor .... *Stoke-on-Trent*
T. G. Whittam .... *Swansea*
N. L. Eaton .... *Sydney*
A. Smith .... *Tees-Side*
F. G. Sandiford .... *Western*
W. B. Pamment .... *Wolverhampton*
R. A. Percival .... *Worcester*

GRADUATE SECTION CHAIRMEN

W. E. Simpson .... *Birmingham* Graduate
J. Shaw .... *Coventry* Graduate
W. Shelton .... *Leeds* Graduate
J. L. Hignett .... *Liverpool* Graduate
W. G. Peters .... *London* Graduate
D. S. Bone .... *Luton* Graduate
.... *Manchester* Graduate
E. K. Stephenson .... *Melbourne* Graduate
G. G. Tate .... *Newcastle upon Tyne* Graduate
.... *Rochester* Graduate
R. H. Clarke .... *Sheffield* Graduate
R. E. Everhard .... *Western* Graduate
E. V. Albrecht .... *Wolverhampton* Graduate

REGIONAL HONORARY SECRETARIES

East & West Ridings ...	D. B. Verity	**Northern Ireland**	P. L. McIlwraith
Eastern	A. B. Brook—Colchester 5151 (Business)	**Scotland**	D. S. Nicol
Midlands	A. C. Turner	**South Eastern**	J. Aikman
North Midlands	D. S. Townsend	**Southern**	J. W. Taylor
Northern	C. E. Darlington	**South Western**	A. Eustace
North Western	J. P. Speakman	**Wales**	P. H. F. Burton

SECTION HONORARY SECRETARIES

AUSTRALIA

Adelaide (South Australia) ...	B. H. M. Coombes, 11 Elmo Avenue, Westbourne Park, Adelaide, Australia.
Melbourne (Victoria,Australia)	A. G. Jones, 13 Laburnum Street, Brighton, S.5, Victoria, Australia.
Melbourne Graduate (Victoria Australia)	G. E. Robert, 18 Rosaline Avenue, Mount Waverley, Victoria, Australia.
Sydney (New South Wales)	K. G. Slorach, 98 Church Street, Castle Hill, New South Wales, Australia.

CANADA

Quebec	J. Brooksbank, 4805, Millette, Pierrefonds, Province of Quebec, Canada.
Toronto	A. M. Hand, 18 Rintella Court, Scarborough, Ontario, Canada.

INDIA

Bangalore	A. R. Iyer, Dy. General Manager, Hindustan Machine Tools Ltd., Jalahalli P.O., Bangalore, 13.
Bombay	C. H. de Sousa, Churchgate House, 32 Veer Nariman Road, Fort, Bombay, India.
Calcutta	C. K. Haldar, Asst. Director General, Ordnance Factories, 6 Esplanade East, Calcutta, 1.

NEW ZEALAND

New Zealand	A. F. Noutch, H. Beaney (Senior) Ltd., 398 - 406 Great North Road, Grey Lynn, W.2, Auckland, New Zealand.

SOUTH AFRICA

South Africa	A. Aitken, 209-211 Pharmacy House, 80 Jorissen Street, Johannesburg, P.O. Box. 10837, South Africa.

UNITED KINGDOM

Birmingham	W. Silberbach, 45 Bagnell Road, Kings Heath, Birmingham, 14—VIC 5241-2 (Business) HIG 4862 (Private)
Cardiff	A. E. Haynes. c/o A. B. Metal Products Ltd., Abercynon, Glamorgan—Abercynon 331 (Business)
Cornwall	F. G. Hawke, 3 Bellevue Terrace, East Hill, Tuckingmill, Camborne, Cornwall—Camborne 3491 (Private)
Coventry	R. L. Aston, Lanchester College of Technology Coventry, Priory Street, Coventry.
Derby	W. F. Radford, 15 Sherwood Avenue, Chaddesden, Derby—Derby 42424 Ext. 137 (Business)
Doncaster	G. R. Wimpenny 16 Tickhill Square, Denaby Main, Doncaster.
Dundee	A. J. Fraser, 51 Fintry Drive, Dundee.
Edinburgh	D. A. Bowman, The Scottish Council (Dev. and Ind.), 1 Castle Street, Edinburgh—Caledonian 7911 (Business)
Glasgow	D. S. Nicol, 35 Manse Road, Bearsden, Glasgow.
Gloucester	A. Emery, 3 Radnor Road, Hatherley, Cheltenham.
Halifax & Huddersfield ...	D. B. Verity, Kendoon, 168 Roils Head Road, Norton Tower, Halifax, Yorks.
Ipswich & Colchester ...	D. G. Petch, "Valandon", 231 Berghott Road, Colchester, Essex.
Leeds	J. Keightley, 42 Kingsley Avenue, Adel, Leeds, 16.
Leicester & District	J. A. Stovin, 14 Queens Drive, Leicester Forest East, Leicester.
Lincoln	H. Wright, 101 Longdales Road, Lincoln—Lincoln 21241 (Business) Lincoln 27462 (Private)
Liverpool	S. Bateman, 17 Brooklet Road, Heswall Hills, Wirral, Cheshire.
London	C. F. Weide, Vickers-Armstrongs (Engineers) Ltd., Crayford Works, Crayford, Kent.
Luton	J. F. W. Galyer, Luton College of Further Education, Park Square, Luton, Bedfordshire.
Manchester	J. P. Speakman, 223 Douglas Road, Atherton, near Manchester—Trafford Park 2431 Ext. 888 (Business) Atherton 538 (Private)
Newcastle upon Tyne ...	L. R. Douglass, Gateshead Technical College, Durham Road, Gateshead, Co. Durham.
Northern Ireland	P. L. McIlwraith, 25 Ward Avenue, Bangor, Co. Down—Bangor (County Down) 5896
Norwich	V. Crowther, 2 Willow Lane, Norwich, Norfolk.
Nottingham	K. Liquorish, 28 Mona Street, Beeston, Nottingham—Nottingham 25-4831 (Business) Nottingham 25-6315 (Private)
Oxford	K. F. Watson, 30 Stanway Road, Headington, Oxford.
Peterborough	N. Holmes, "Arncliffe". 11 Mary Armyn Road, Orton Longueville, Peterborough—Peterborough 67474 (Business)
Preston	M. A. Goody, 1 Langdale Crescent, Ribbleton, Preston, Lancashire.
Reading	P. J. Smallbone, "Maryfield", Darlington Road, Basingstoke, Hants.
Rochester & District ...	W. G. Clements, 11 Charing Road, Gillingham, Kent.
Sheffield	W. Edwards, 2 Wollaton Drive, Bradway, Sheffield.
Shrewsbury	W. M. Buchan, Llanberis, 36 Mytton Oak Road, Shrewsbury—Shrewsbury 51544 (Business) Shrewsbury 4880 (Private)

UNITED KINGDOM — *continued*

Southampton	R. C. C. Wadey, White Lodge, Holly Road, Ashurst, Southampton—Southampton 75533 (Business).
South Essex	E. R. Easman, 4 Onslow Close, Chingford, E.4—Seven Kings 3456 (Business)
Stoke-on-Trent	W. Elliott, 1 Longview Avenue, Alsager, Stoke-on-Trent.
Swansea	C. L. Clarke, 11 Alder Road, Cimla, Neath, South Wales.
Tees-Side	T. Young, 47 The Headlands, Marske-by-the-Sea, York—Redcar 3909 (Private)
Western	A. Eustace, 19 Ferndale Road, Northville, Bristol, 7—Bristol 693871 Ext. 243 (Business)
Wolverhampton	I. R. Jones, "Shalimar", Clive Road, Pattingham, Wolverhampton.
Worcester	R. Wheeler, Old Farm House, 7 Parish Hill, Bournheath, near Bromsgrove, Worcestershire.

CORRESPONDING MEMBER IN MALTA

L. Walmsley, B.I.M Ltd., Marsa Industrial Estate, Malta, G.C.

CORRESPONDING MEMBER IN MIDDLE EAST

J. Merkine, 15 Sha'anan Street, Ramat Gan, Israel.

CORRESPONDING MEMBER IN RANGOON

J. T. Foster, Office of the Principal, Regional Marine Diesel Training Centre,
Dalla Dockyard, Inland Water Transport Board, Phayre Street, Rangoon, Burma.

CORRESPONDING MEMBER IN FEDERATION OF RHODESIA AND NYASALAND

R. P. W. Curtis, Copper Belt Technical Foundation, Chingola, Northern Rhodesia.

GRADUATE SECTION HONORARY SECRETARIES

Birmingham	A. Parkinson, 64 Wychall Road, Northfield, Birmingham, 31—East 2051 (Business) Priory 4073 (Private)
Cardiff	T. E. Morgan, 11 Heol, Fawr, Nelson, Glamorgan.
Coventry	N. A. Martin, 2 Home Farm Crescent, Whitnash, Leamington Spa.
Leeds	B. Noble, "Lane side", 25 Intake Lane, Batley, Yorks.—Leeds 637991 (Business)
Liverpool	T. Drysdale, "Stoneleigh", 2 Livingston Drive South, Liverpool, 17—Hunts Cross 2121 Ext. 46 (Business)
London	B. W. Jenney, 58 Langdale Gardens, Perivale, Middlesex.
Luton	D. A. Slough, 41 Felix Avenue, Luton, Bedfordshire—Luton 2440 Ext. 286 (Business) Luton 286 (Private)
Manchester	J. R. Ellis, 50 Avonlea Road, Sale, Cheshire.
Newcastle upon Tyne ...	J. D. Rennison, 26 Kells Gardens, Low Fell, Gateshead, 9, Co. Durham—Low Fell 7-7721 (Private) Hebburn 382441 Ext. 137 (Business)
Rochester & District ...	D. M. Samson, 123 York Road, Maidstone, Kent.
Sheffield	P. Brown, 21 Rowan Tree Dell, Totley, Sheffield—Sheffield 23038 (Business) Sheffield 365984 (Private)
Western	J. Russell, 1 Beaufort Road, Clifton, Bristol—Bristol 693871 Ext. 390 (Business) Bristol 33437 (Private)
Wolverhampton	R. Wise, 52 Pargeter Street, Walsall, Staffs.

LOUGHBOROUGH COLLEGE STUDENT SECTION

Chairman:
A. K. Bird, c/o 8 Shannon Square, Lane Head, Burnley, Lancs.

Honorary Secretary:
J. B. Carmichael, Hazlerigg Hall, Ashby Road, Loughborough, Leics.

MATERIALS HANDLING GROUP

Chairman:
H. Bond, Midland Electric Manufacturing Co. Ltd., Reddings Lane, Tyseley, Birmingham, 11.

Secretary:
S. Horwood, Assistant Education and Technical Officer, 10 Chesterfield Street, Mayfair, London, W.1.

EDUCATION DISCUSSION GROUPS

London Centre

Chairman:
G. R. Spurdle, "Kenholme", 110 Feltham Road, Ashford, Middlesex.

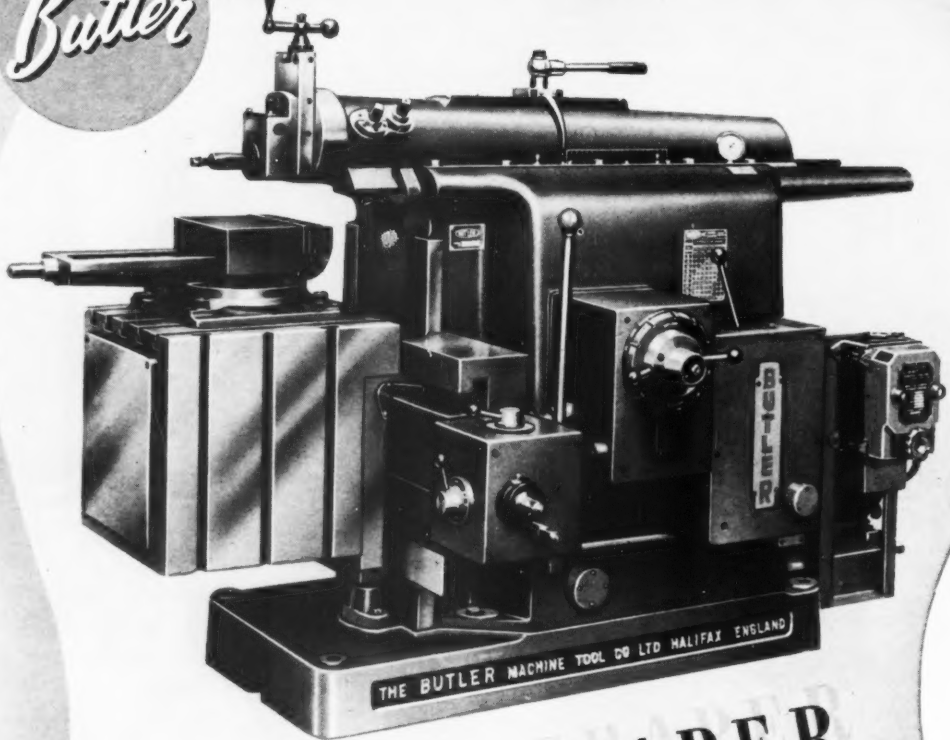
Honorary Secretary:
D. R. C. Holmes, 35 Sandringham Drive, Ashford, Middlesex.

Midland Centre

Chairman:
W. L. Jackson, Senior Lecturer in Production Engineering, Chance Technical College, Smethwick

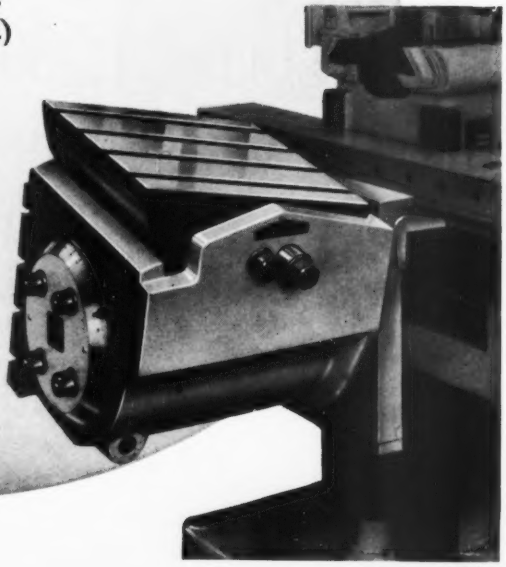
Honorary Secretary:
N. Ward, 88 Sutton Oak Road, Streetly, Sutton Coldfield.

Butler



18" SUPER SHAPER

Also available with 26 in. stroke.
Special designs of swivelling or combined swivelling and tilting tables (shown in illustration on right) instead of rectangular table (seen on machine above)



The BUTLER MACHINE TOOL Co. Ltd.
HALIFAX ENGLAND PHONE 61641-4
PLANING, SHAPING & SLOTTING MACHINES

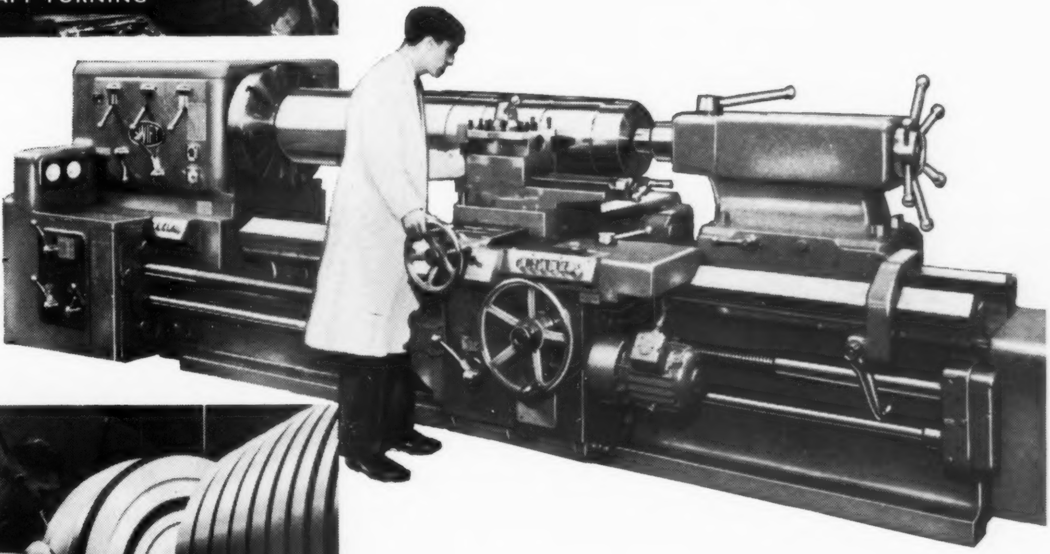
BRITISH MACHINE TOOL MAKERS ASSOC. LTD ABMTM

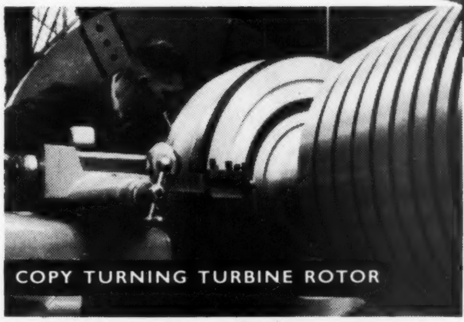
B337-IB

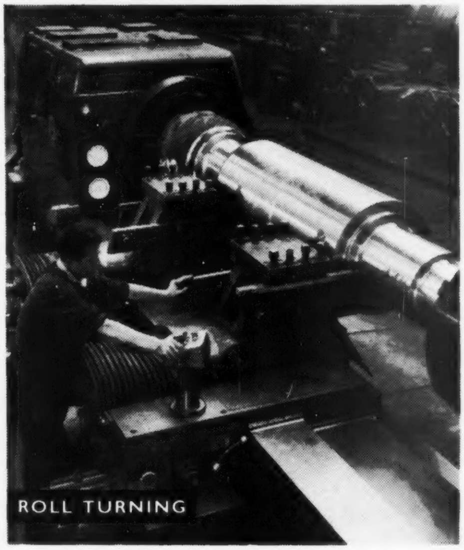

INDUCTION HEATING EQUIPMENT
GENERAL PURPOSE FURNACES
CONTINUOUS CARBO-NITRIDING FURNACES
GAS CARBURISING EQUIPMENT

SWIFT LATHES

HIGH QUALITY MACHINE TOOLS AVAILABLE IN A WIDE RANGE OF STANDARD TYPES







These Lathes are of up-to-date design with adequate power and rigidity together with ranges of feeds and speeds that allow full use to be made of carbide tooling as well as heavy duty cutting with high speed steel tools.

The large illustration shows a "C" type, Series 60 lathe which has eighteen spindle speeds through gearing and a further nine fast speeds through a belt drive direct onto the spindle. This lathe is available with swing over bed 2 ft. 9 in., 3 ft. 3 in. or 3 ft. 9 in. and capacity between centres 7 ft. 6 in., 9 ft. 0 in. or 10 ft. 6 in. respectively. It is an exceptionally robust machine capable of using up to 50 h.p.

Other Swift Centre Lathes and Roll Turning Lathes are available for a wide range of applications and in capacities up to 72 in. swing over bed and any bed length. Copy Turning equipment can be supplied if required for your production.

Write today for full details of Swift Lathes in the capacity range you have in mind.

GEORGE SWIFT & SONS LTD.

HALIFAX · ENGLAND

Member of the Asquith Machine Tool Corporation

Sales and Service for the British Isles

DRUMMOND - ASQUITH LIMITED

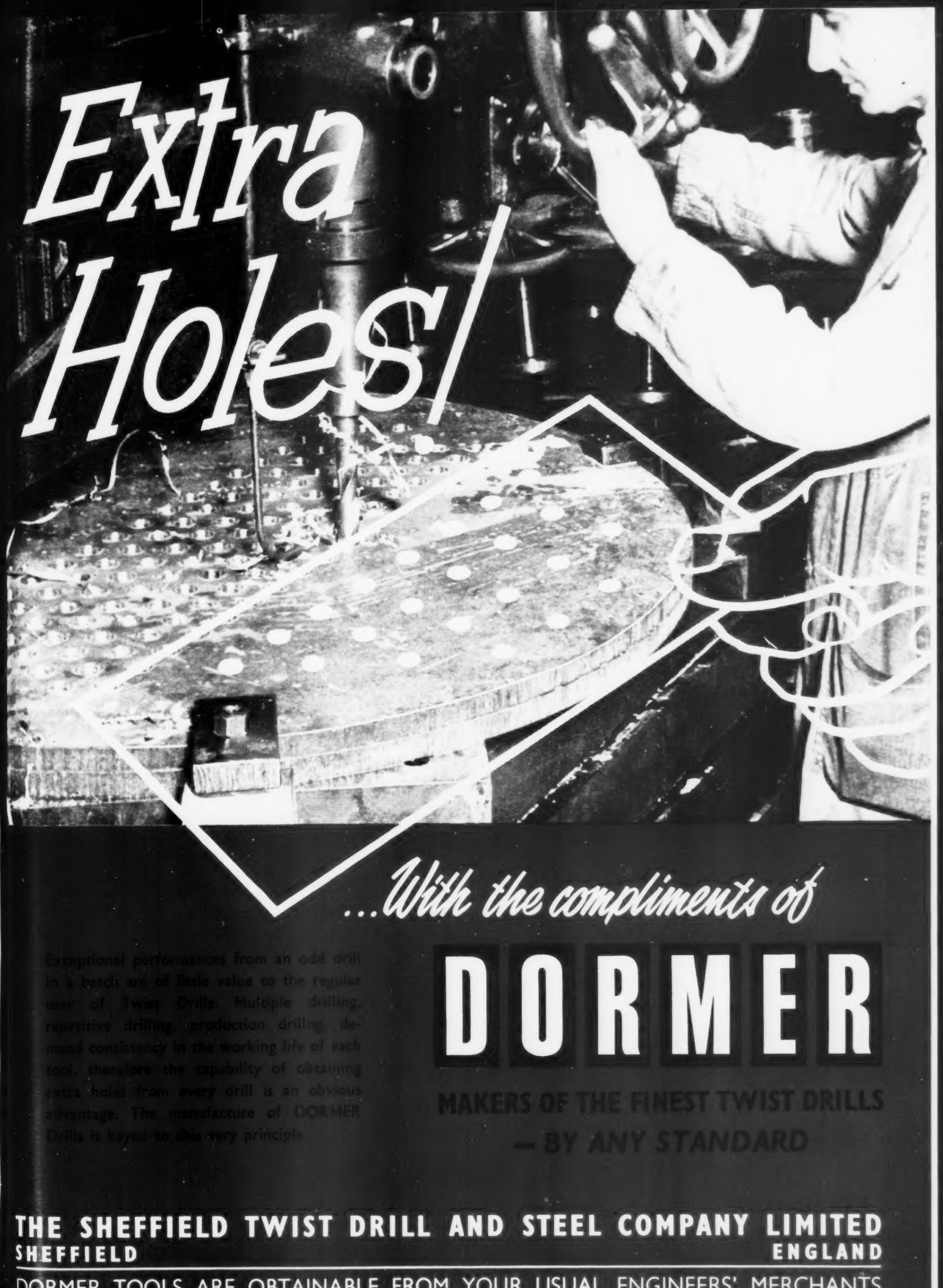
Member of the Asquith Machine Tool Corporation

KING EDWARD HOUSE, NEW ST., BIRMINGHAM *Phone: Midland 3431.* *Also at* LONDON *Phone: Trafalgar 7224* & GLASGOW *Phone: Central 0922*

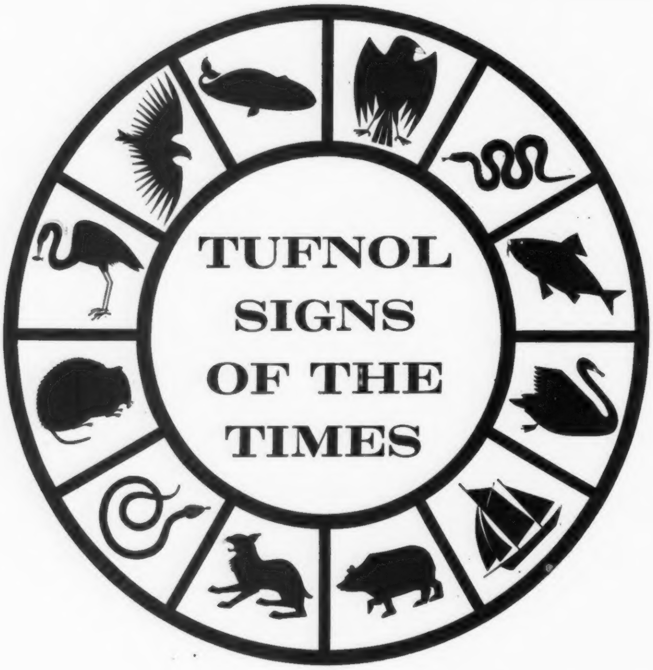
es
t

e

td.
Enfield



Extra Holes!
...With the compliments of
DORMER
MAKERS OF THE FINEST TWIST DRILLS — BY ANY STANDARD
Exceptional performances from an odd drill in a batch are of little value to the regular user of Twist Drills. Multiple drilling, repetitive drilling, production drilling, demand consistency in the working life of each tool, therefore the capability of obtaining extra holes from every drill is an obvious advantage. The manufacture of DORMER Drills is keyed to this very principle
THE SHEFFIELD TWIST DRILL AND STEEL COMPANY LIMITED
SHEFFIELD ENGLAND
DORMER TOOLS ARE OBTAINABLE FROM YOUR USUAL ENGINEERS' MERCHANTS



Vole–sign of Tufnol

Those people born under the sign of the Vole burrow their way to the top of their profession to become chief purchasing officers, chief engineers, chief draughtsmen and chief designers. Vole men are specialists in their field of country and know exactly what they want. Vole men are perfectionists. They yearn for one material that combines the properties of many—a material that is strong yet light and hard wearing, resistant to corrosion and a good electrical insulator. They expect this ideal material to resist deterioration in storage, to machine easily with ordinary tools, and to be available in sheets, tubes, rods, angles and channels. Many Vole men have already ferreted out this remarkable material—"VOLE" brand Tufnol. They have also discovered that Tufnol is available in eleven other brands, each with pre-determined properties.

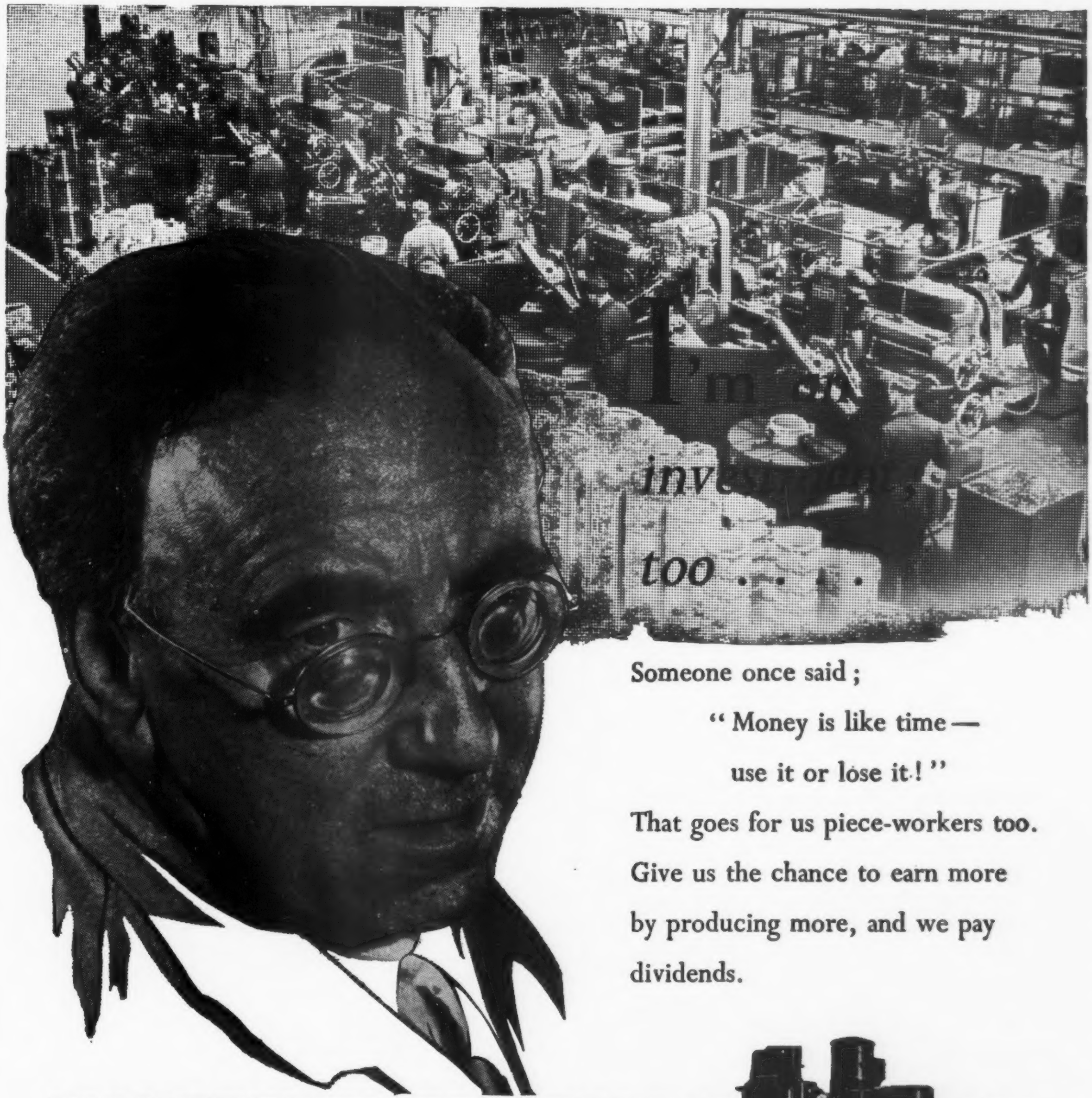
All brands of Tufnol are laminated plastics, *each* formulated to satisfy specific requirements. If your birthday falls between January 1st and December 31st, this could be your lucky week—the week you discovered Tufnol.

'Phone or write to your local Tufnol Branch Office, and we predict that you will thank your lucky stars.

TUFNOL
(REGD TRADE MARK)

Tufnol Limited,
Perry Barr, Birmingham 22B

PS



Someone once said ;

" Money is like time —

use it or lose it ! "

That goes for us piece-workers too.

Give us the chance to earn more

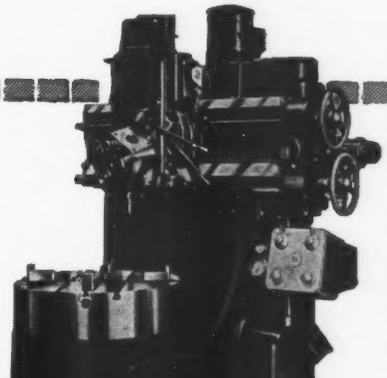
by producing more, and we pay

dividends.

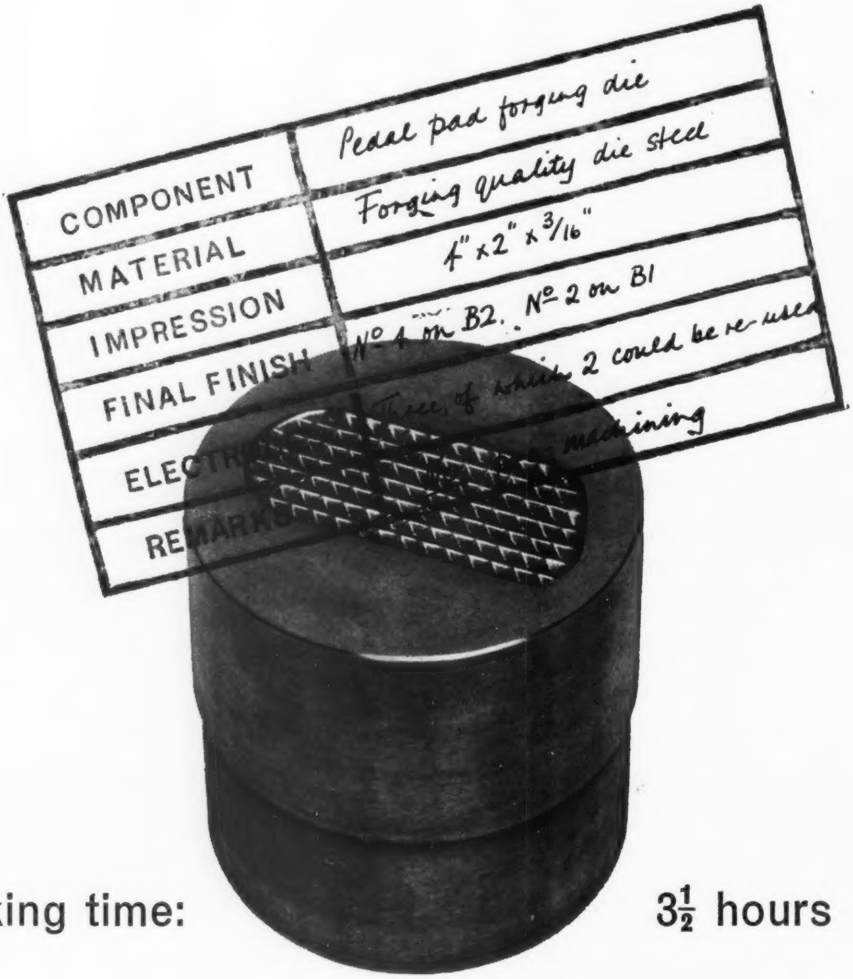
Companies investing in a realistic plant replacement policy find their reward in higher consistent output, keen and contented workpeople, and bigger profits.

When the machines in question are boring mills as popular as the Webster & Bennett, they are prepared to order well in advance. This is one of the reasons why we can seldom offer machines for early delivery.

Ought you to see about a replacement order now ?



WEBSTER & BENNETT LTD., COVENTRY, ENGLAND



Sparking time: $3\frac{1}{2}$ hours

THIS PEDAL PAD FORGING DIE took $3\frac{1}{2}$ hours to make on the new GKN Spark Machine, Model B1. How long would it have taken by other methods?

When you've worked it out, consider the GKN Spark Machine. *It is faster, more accurate, more versatile, more compact and better designed than any other machine of its kind,* yet both installation and running costs are low.

The GKN Spark Machine was designed by the GKN Group Research Laboratory. Not only is it backed by all the Laboratory's technical resources, but *every user of the GKN spark machine can count on regular visits from the makers' technical representative to ensure that he gets the most from his machine.*

Whether you are engaged in forging, wire-drawing or press-tool making, the GKN Spark Machine is something it will pay you to know about. Ask our sales agents for an illustrated brochure on the GKN Spark Machine (Models B1 & B2). Ask them now.

The GKN Spark Machine
DESIGNED BY THE GKN GROUP RESEARCH LABORATORY

WELSH METAL INDUSTRIES LTD.,
Caerphilly, Glamorganshire.
Sales Agents U.K.
M. C. Layton Limited, Abbey Wharf,
Mount Pleasant, Alperton, Wembley, Middx.
Rudkin & Riley Limited,
Cyprus Road, Aylestone, Leicester.
Alfred Herbert Ltd., P.O. Box 18,
Red Lane Works, Coventry.

A MEMBER OF THE GKN GROUP OF COMPANIES


COMPOSITE VEE VICE
SURFACE GAUGES
ANGLE PLATES
VEE BLOCKS
TAP
WRENCH
CHUCK TYPE
TAP
WRENCH
ADJUSTABLE
BAR TYPE
PIN VICES
VEE
BLOCKS
& CLAMPS
SCRIBERS
AUTOMATIC
CENTRE PUNCH

ineer

ST

ghton

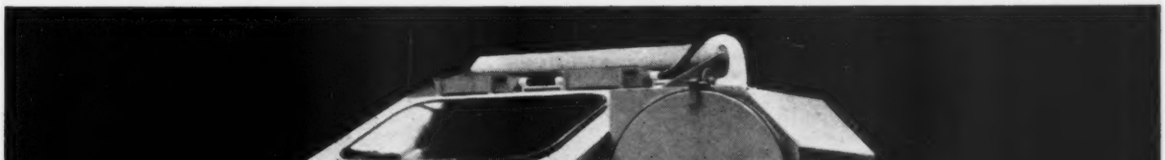
WORLD

VACU-BLAST

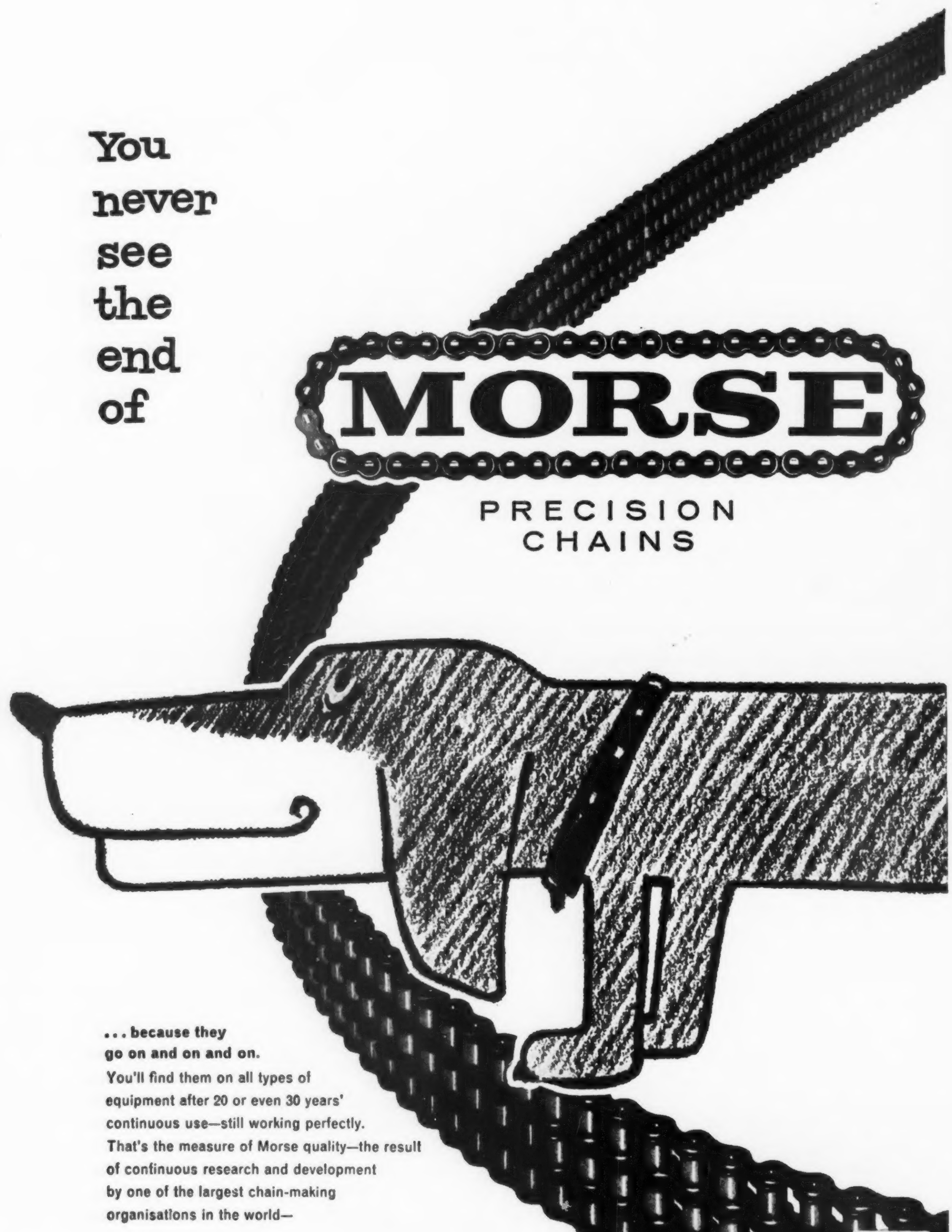
The DRY-HONER . .

. . preserves the mould contour—does not erode
. . is completely dry in operation—no solvents or liquids
. . eliminates time loss in re-heating to curing temperature
. . increases number of cures between cleaning operations
. . attains an "as new" finish

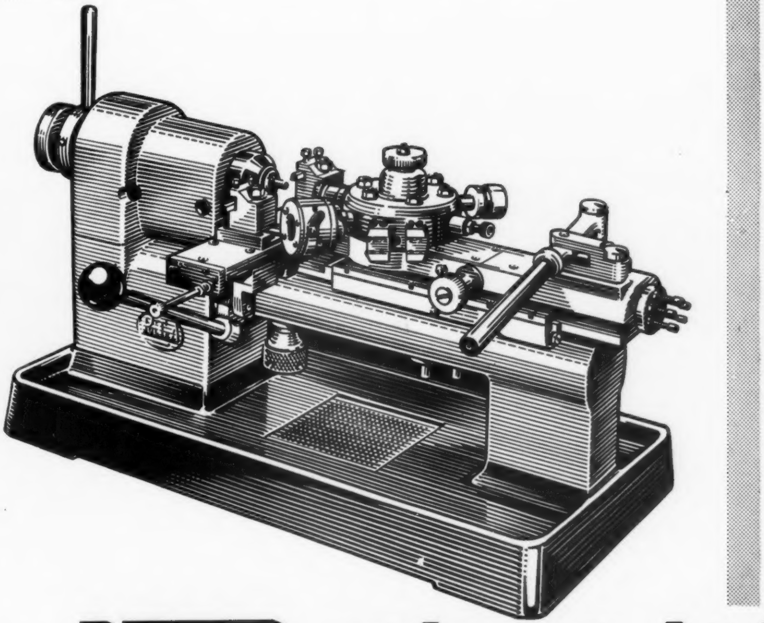
The rubber moulds illustrated have been cleaned in the VACU-BLAST DRY-HONER



WELLCROFT ROAD · SLOUGH · BUCKS · *Telephone: SLOUGH 24507/9.*



You never see the end of
MORSE
PRECISION CHAINS
... because they go on and on and on.
You'll find them on all types of equipment after 20 or even 30 years' continuous use—still working perfectly. That's the measure of Morse quality—the result of continuous research and development by one of the largest chain-making organisations in the world—
MORSE CHAIN DIVISION · BORG-WARNER LIMITED
LETCHWORTH · HERTS · TEL: LETCHWORTH 2170
Manufacturers of Automatic Transmissions, Torque Converters, One Way Clutches, Morse Chains and Hartcliffe Chains
B-W



Electrical Aids in Industry — Data Sheet **20**

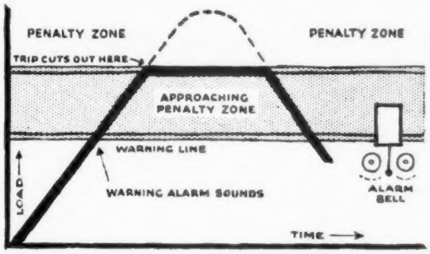
Load Factor Improvement

Most industrial electricity tariffs consist of a fixed charge based on the maximum demand for electricity by the works and a running charge for each unit (kWh) of electricity used. Broadly speaking, the fixed charge covers the capital cost of generating, transmitting and distributing equipment for the particular demand and the running charge covers the cost of generating the units.

Thus, if the factory maximum demand is reduced for the same level of consumption or is held constant for an increased consumption, the cost per unit will be reduced. This is termed improving the 'load factor': load factor being defined as the ratio of the number of units supplied during a given period to the number of units that would have been supplied had the maximum demand been maintained throughout the period; it is usually expressed as a percentage. Some ways in which load factor can be improved are:

SUPERVISION AND CONTROL OF MAXIMUM DEMAND

A maximum-demand alarm gives a warning when the maximum demand is about to be exceeded. One of the simplest devices has two warning contacts, but, as a useful addition, an auxiliary relay can be supplied so that non-essential load can be tripped automatically.



The Load Limiter, an automatic device, meets the requirements of medium and large consumers who wish not only to control their system loading to some target maximum but also to improve the load factor in order to increase the overall economy of the plant.

EXAMPLES OF REDUCTION IN MAXIMUM DEMAND

Broadly speaking, loads which contain some storage element can be transferred from on-peak to off-peak times. Examples are: charging electric batteries used in industrial trucks and road vehicles; pumping loads in drainage schemes; water pumping in quarries, gravel pits and other open-air workings; large cold-storage warehouses; ice-making factories in which cost of power is a sufficiently large item of the operating expense to make a reduced charge acceptable.

Many processes at times of peak demand can, under controlled conditions, tolerate a temporary reduction, or even cessation, of supply without any serious effect on the product. With electro-chemical processes such as in the manufacture of hydrogen peroxide no difficulty arises from periodic interruptions at short or even no notice.

In a plastics factory the management arranged for dies to be switched on by time switches one after another early Monday morning so at the beginning of work all dies had reached their operating temperatures. Previously they were switched on more or less simultaneously by hand when work started, resulting in an abnormally high demand.

In a certain chemical works compressed air is used for blowing out containers for plastic material. The nature of this operation is such that the consumption of air is spasmodic and irregular. The demand-recording meter in this works showed that the 18-kilowatt motor driving the air compressor was frequently cutting in on top of the factory load, thus incurring a higher maximum-demand charge. In this case all that was necessary was to ensure that the air receiver only required charging at night-time or at other off-peak times. It was found that the existing receiver had such a small capacity that the pump had to operate to recharge it almost every time the blowing operation took place. This small receiver was therefore replaced by a receiver of large enough capacity to maintain the blowing requirements over the peak periods without further charging.

EXAMPLES OF INCREASED CONSUMPTION FOR THE SAME MAXIMUM DEMAND

Often when the requirements of a factory are studied it is found that there are additional processes for which electro-heat can economically be employed because furnaces or other equipment can be arranged to be switched off or to take a reduced load during periods of peak demand. A sheet metal foundry with an early morning peak found that it would be an economical proposition to use an infra-red oven switched on after the peak period had passed because such ovens are ready for use in a few minutes. The possibilities of electric space heating in this respect are dealt with in Data Sheets 18 and 19.

For further information, get in touch with your Electricity Board or write direct to the Electrical Development Association, 2 Savoy Hill, London, W.C.2. Telephone: TEMple Bar 9434.

Excellent reference books are available on electricity and productivity (8/6 each, or 9/- post free) — 'Higher Industrial Production with Electricity' is an example.

E.D.A. also have available on free loan in the United Kingdom a series of films on the industrial uses of electricity. Ask for a catalogue.

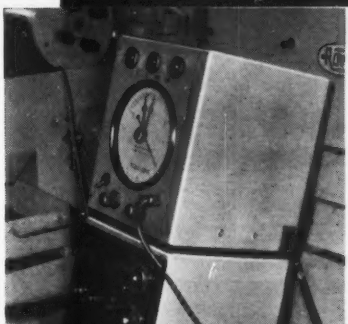
CUT HERE

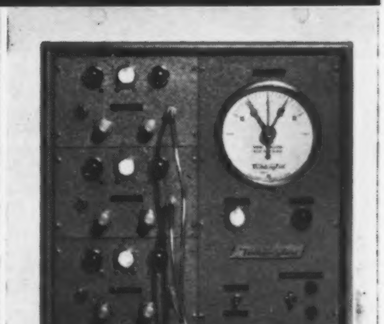
7926

Whatever your gauging problems

Teddington

have the answer





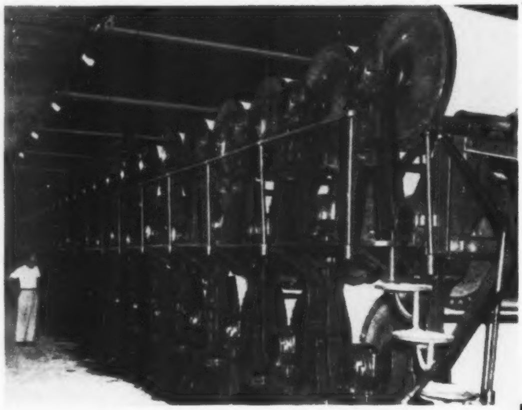
AUTOMATIC Teddington CONTROLS

TEDDINGTON INDUSTRIAL EQUIPMENT LIMITED · SUNBURY-ON-THAMES · MIDDLESEX

TELEPHONE: SUNBURY-ON-THAMES 600 · GRAMS & CABLES: TEDDEQUIP, SUNBURY-ON-THAMES · TELEX: 2-2742 TEDDCONTSNBURY

1296

Norgren MICRO-FOG BEARING LUBRICATION



A PROVED COST SAVER

A typical example of how Norgren MICRO-FOG Lubrication has lowered bearing temperatures as much as 50°F. and reduced oil consumption by 66%. A Norgren MICRO-FOG Lubricator creates a fog of extremely fine particles of oil that can be distributed through low pressure air lines to satisfy all lubrication needs on the machine. MICRO-FOG eliminates sumps, pumps oil filters and high pressure piping, provides a big cut in equipment requirements, needs fewer oil seals and reduces costly maintenance and downtime.

ECONOMIES YOU GET WITH **NORGREN**

Automatic and continuous lubrication. Hand oiling eliminated. Lubricant consumption greatly reduced. Uneven bearing wear eliminated. Helps keep work area cleaner.

Full details from

C. A. NORGREN LTD.

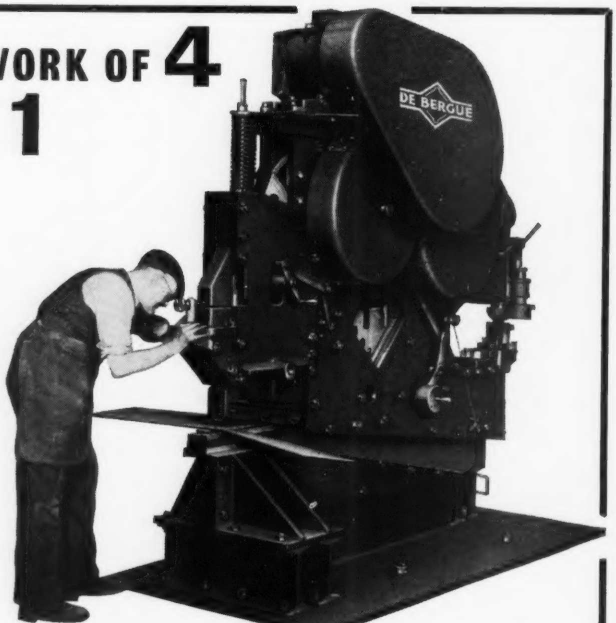
SHIPSTON-ON-STOUR, WARWICKSHIRE

Telephone: Shipston-on-Stour 676 (3 lines)

M-W 139

THIS MACHINE DOES THE WORK OF 4
TAKES UP THE SPACE OF 1

- PUNCHING
- SECTION CROPPING
- PLATE SLITTING
- NOTCHING



THE

DE BERGUE 4 IN 1

MULTI-PURPOSE MACHINE

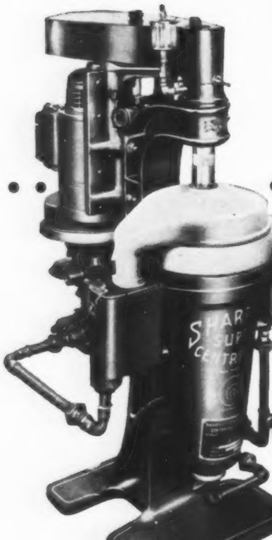
Send for Brochure (W)

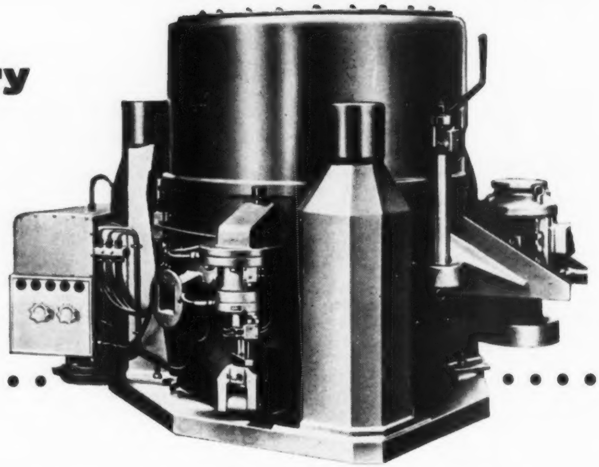
Made in several sizes, these, robust machines with recent improvements in design are an invaluable asset to constructors in STEEL.

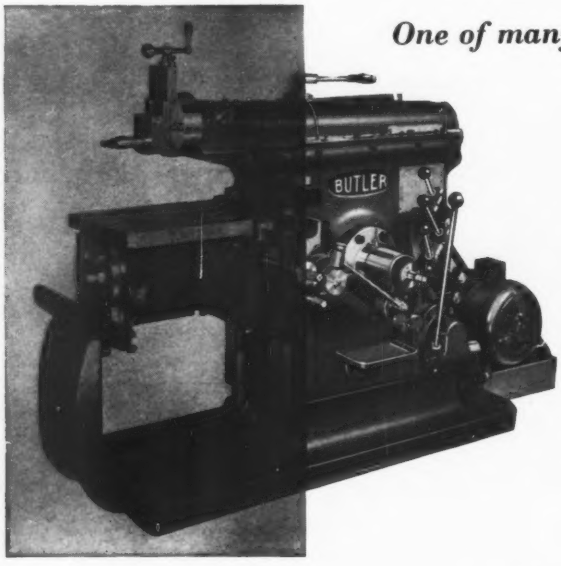
A new range of Guillotines of modern design will shortly be available. Full particulars on request.

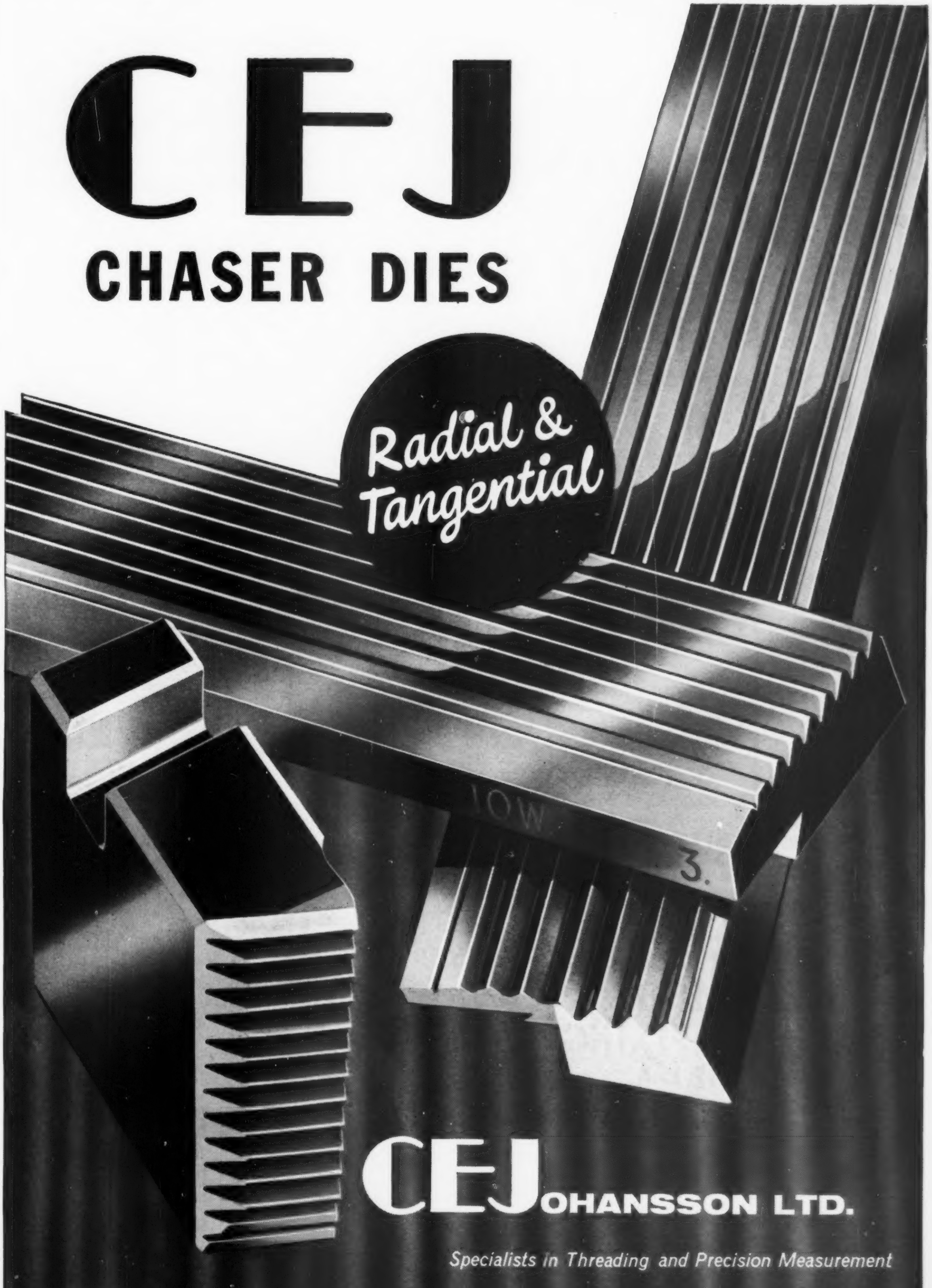
DE BERGUE MACHINE TOOLS LIMITED

WEST GORTON, MANCHESTER, 12, ENGLAND **Telephone EASt 2771**

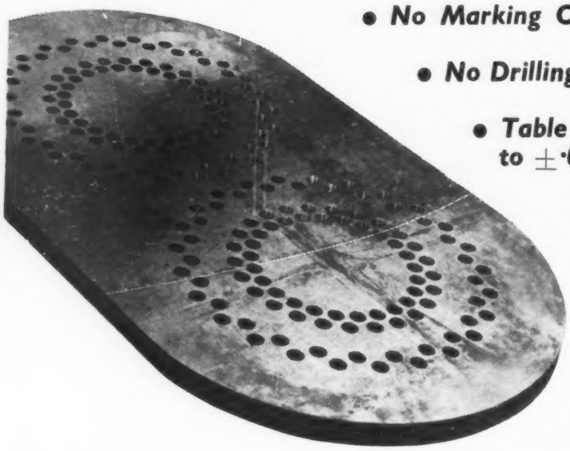




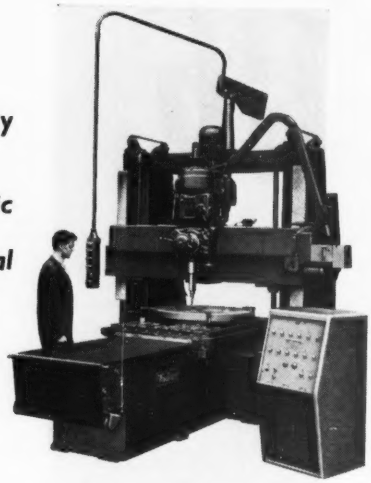

BUTLER


CEJ
CHASER DIES
Radial & Tangential
10W
3.
CEJOHANSSON LTD.
Specialists in Threading and Precision Measurement
SOUTHFIELDS ROAD, DUNSTABLE, BEDS. TEL: DUNSTABLE 62422

POSITIONAL DRILLING MACHINES



- *No Marking Out*
- *No Drilling Jigs*
- *Table Positional Accuracy to $\pm$·001″*
- *Fully Automatic*
- *Tape or Dial Setting*



Wadkin Positional Drilling Machine TCD1

This machine will accurately position holes up to 2 in. diameter in steel. It eliminates all marking off as well as the necessity of using drilling fixtures. Once the tape has been punched — a relatively simple operation — exact repetitions of even the most complicated drilling jobs are guaranteed at any time. The price of this machine, complete with positioning control system, compares favourably with a conventional drilling machine of the same capacity. Either single or multi-station turret heads can be fitted. May we send you more details ?

Wadkin

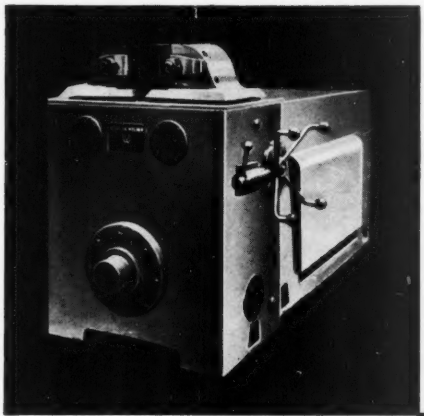
Wadkin Ltd., Green Lane Works, Leicester. Telephone : 68151. London Office : 62-64 Brook Street, W.1. Telephone : MAYfair 7048

Mould Machining

Our mould design service is supported by full manufacturing facilities both on the machine and on the bench.

- * PLASTIC MOULDS
- * DIE CASTING TOOLS
- * SPECIAL TOOLS
- * PRESS TOOLS
- * JIGS & FIXTURES

UNIVERSAL TOOLS LIMITED, TRAMWAY PATH, MITCHAM, SURREY. Tel: MITcham 6111



TYPE RD 125 HHV

'RIBBACK' HAMMERING MACHINES

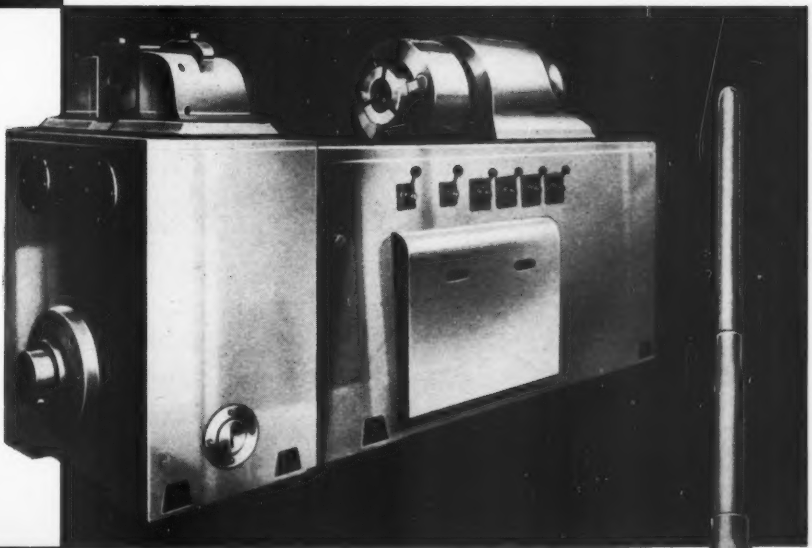
For cold and hot forming of steel and non-ferrous metals

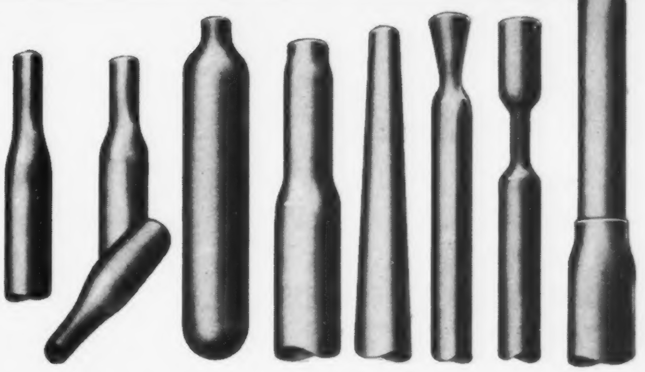
Working diameter up to 13 inches

Silent, Vibration free, wear resisting construction

right
TYPE RD 230 HH/Z
'RIBBACK' HAMMERING MACHINE
WITH AUTOMATIC FEED

below
TYPE RU 40





Tube points, round or folded for tube-drawing | Steel Bottles | Boiler Tube | Conical Tube | Constrictions | Tube masts reduced and shrunk

Usine de Wecker
S.à r.l. Wecker/Luxembg.

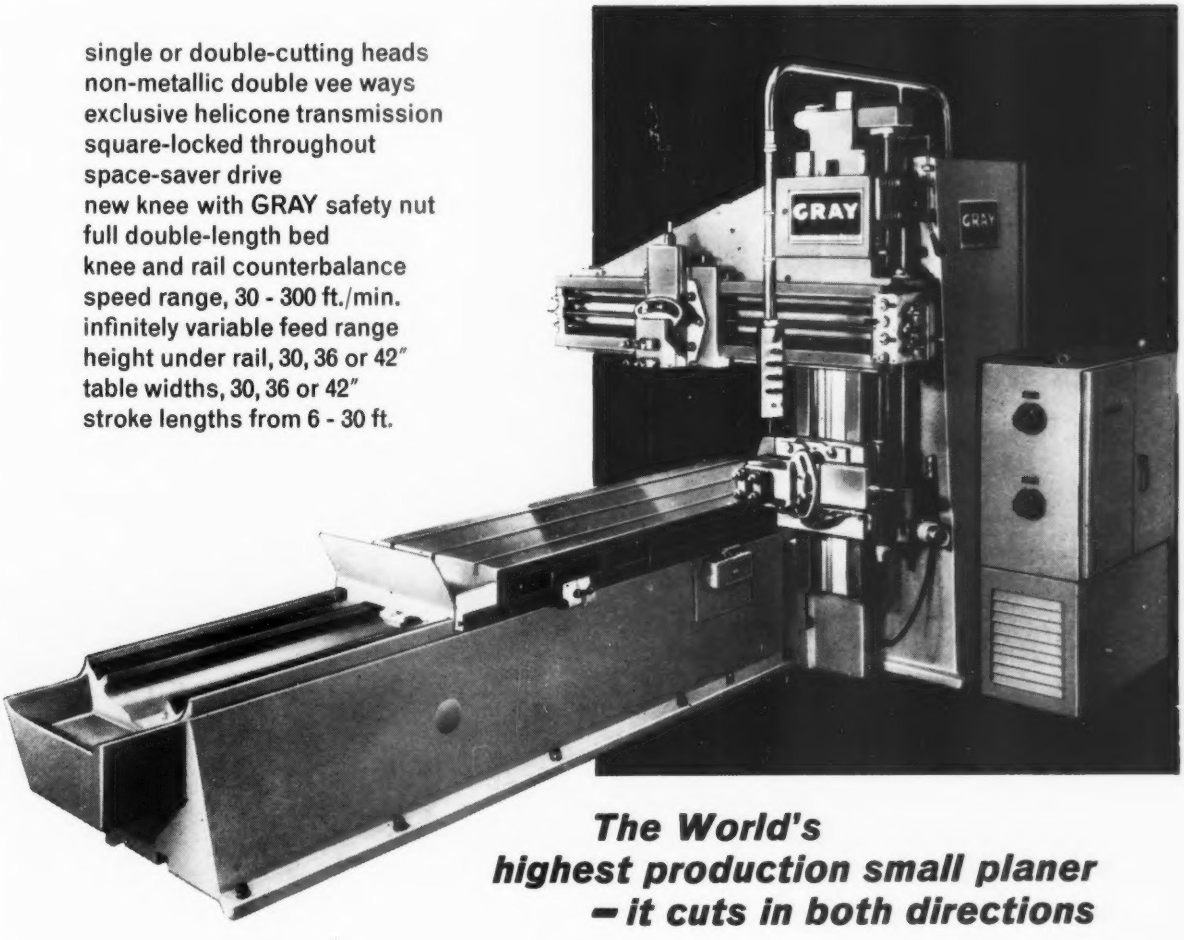
Represented by **D.M.M. (Machinery) Ltd.**
Universal House, 60 Buckingham Palace Road, London S.W.1
Tel. No. Sloane 0701

GRAY

flying scot

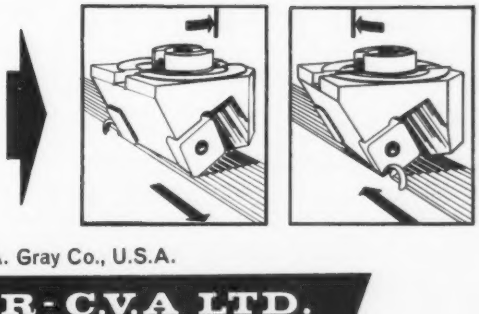
30"-36"-42"

single or double-cutting heads
non-metallic double vee ways
exclusive helicone transmission
square-locked throughout
space-saver drive
new knee with GRAY safety nut
full double-length bed
knee and rail counterbalance
speed range, 30 - 300 ft./min.
infinitely variable feed range
height under rail, 30, 36 or 42"
table widths, 30, 36 or 42"
stroke lengths from 6 - 30 ft.



The World's highest production small planer – it cuts in both directions

With GRAY Universal Heads (optional) the Flying Scot cuts both ways. Heavy duty carbide roughing without losing its superb precision. A holder containing two opposed standard carbide tips is secured to a large spindle mounted in the slide. The spindle oscillates at the end of each stroke so that one tip rotates down into the cut position while the opposing tip rotates up and out of the work.
Universal Heads in no way restrict the versatility of the Flying Scot as a conventional planer.



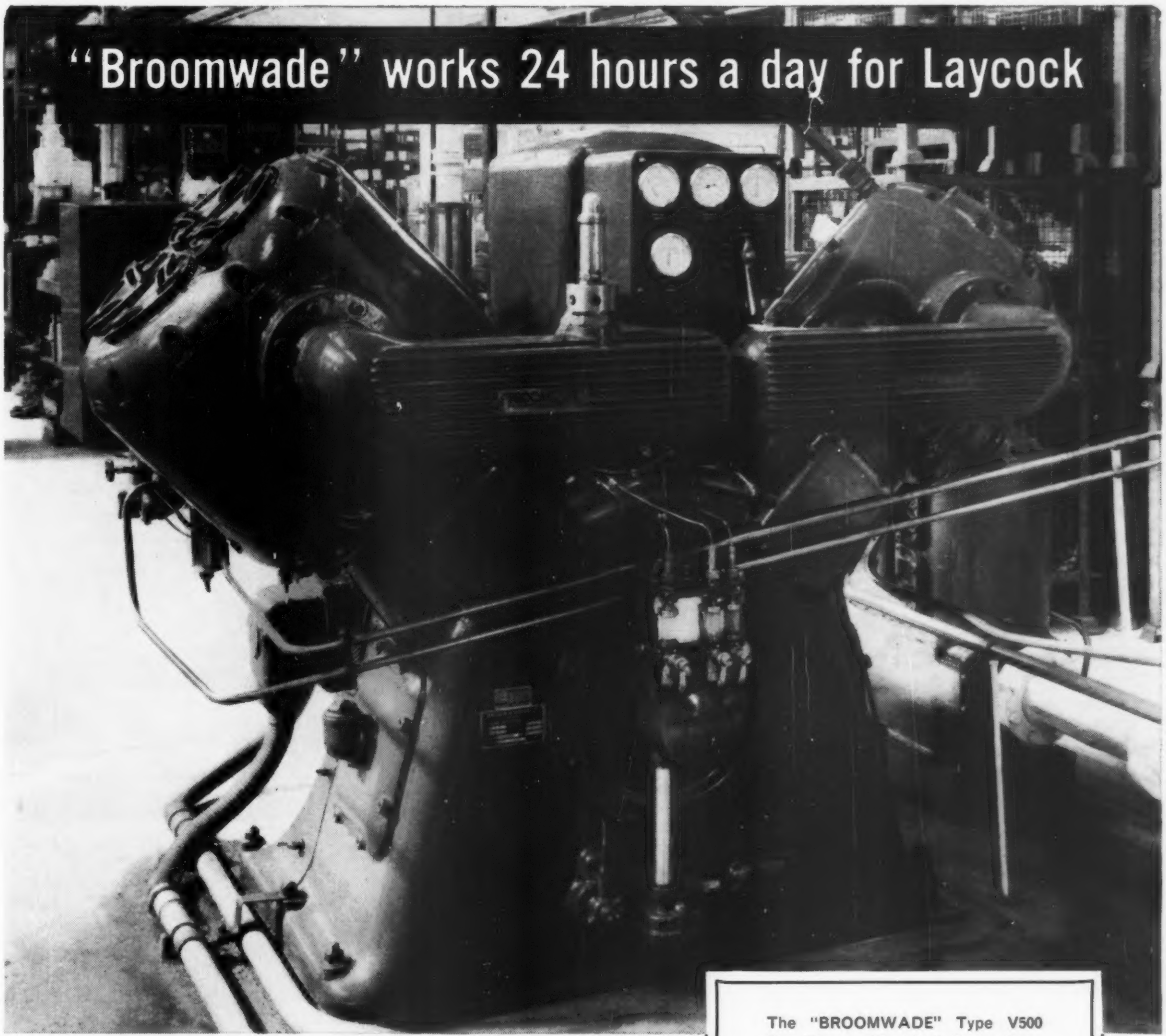
Manufactured and Distributed in U.K. by agreement with G. A. Gray Co., U.S.A.

KEARNEY & TRECKER - C.V.A LTD.

GARANTOOLS HOUSE • PORTLAND ROAD • HOVE • SUSSEX *Tel: Hove 47253 Cables: Ceveatools (Telex) Hove*

LONDON · BIRMINGHAM · GLASGOW · MANCHESTER · BRISTOL

NRP 3644



Over 13 months ago, Messrs. Laycock Engineering Limited—the famous manufacturers of automobile components including the Laycock-de Normanville Overdrive—installed one of the latest "BROOMWADE" Type V500 Air Compressors at their Sheffield works.

Driven by a direct coupled electric motor, thus occupying the minimum of floor space, this compressor of advanced design has operated with complete satisfaction 24 hours per day, for 5 days a week, including many weekends.

The V type 90° arrangement of the Cylinders provides excellent running balance and this, coupled with the absence of vibration, enables the complete unit to be bolted to the factory floor without special foundations.

Here, indeed, are valuable economies—**COMPACTNESS, LOW INSTALLATION** and **MAINTENANCE COSTS** plus **RELIABILITY.** They pay off handsomely at Laycocks—they could do the same for you.

Write today for full details.

The "BROOMWADE" Type V500 Two-Stage, Double-Acting Compressor installed at the Victoria Works of Messrs. Laycock Engineering Ltd. Delivering 525 c.f.m. of free air at 100 p.s.i., this compact unit provides a round-the-clock supply of compressed air for air chucking, air fixtures, clamping, indexing, operating hand-held pneumatic tools, and air hoists. The compressed air supply is also used for mixing and agitating the neutralizing and pickling baths; for shot blasting; for metal and paint spraying; for air-cooling oil quenching baths; for clearing fumes; and for operating roof ventilators.

Photograph by courtesy of Messrs. Laycock Engineering Limited.

"BROOMWADE"

Air Compressors and Pneumatic Tools—Your Best Investment

BROOM & WADE LTD., P.O. BOX NO. 7, HIGH WYCOMBE, BUCKS.
Telephone: High Wycombe 1630 (10 lines) Telex: 83—127

873 SAS

Metolux REGD TRADE MARK MOULDABLE METAL

Solves the Problem

If you are troubled by tiresome repair or 'build-up' problems in the foundry or workshop — Metolux could be the answer. Metolux is a high quality cold casting metal which is mixed in seconds, applied in minutes and sets in half an hour. It can be drilled, tapped, machine ground or turned and will withstand temperatures up to 450° F.

Metolux has proved highly successful for numerous repair jobs and applications. Why not give it a try?

Metolux Aluminium

Filling porosity and defects in aluminium castings. General repairs and build up of metal patterns. Manufacture of prototypes. Repairs and manufacture of moulds for plastic and rubber goods. Repairs to car bodies, petrol tanks, cylinder blocks, radiators, etc. Protective coatings against corrosion.

Metolux Iron

Repairs to lathe beds, press beds, patterns, formers and all general surfaces. Prototype moulds for plastic and rubber goods. Filling porosity and defects in iron and steel castings. Manufacture of chuck jaws drilling and assembly jigs, soft jaws, etc. Protective coatings against corrosion.

Send for further details to:

PLASTICS & RESINS LTD.

The Airport, Pendeford,
Wolverhampton, Staffs,
Telephone: Fordhouses 2454/5

Let us be your machine shop!

Complete facilities plus precision & service second to none

- Capstan and centre lathe work
- Milling—all types
- Surface and universal grinding
- G-SIP jig boring
- Centreless grinding
- Copy turning
- Cridan screw cutting
- Thread milling

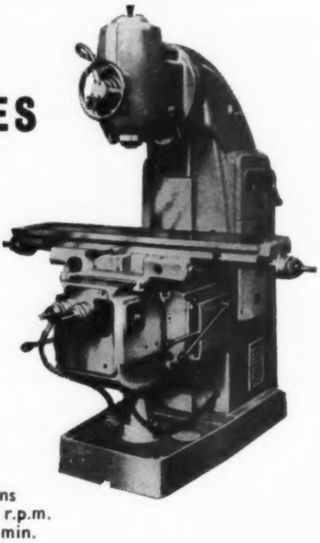
. . . as well as shaping, honing, drilling, toolmaking, etc. to meet your every need.
A·I·D & A·R·B Approved

MARSDEN & SHIERS LTD.

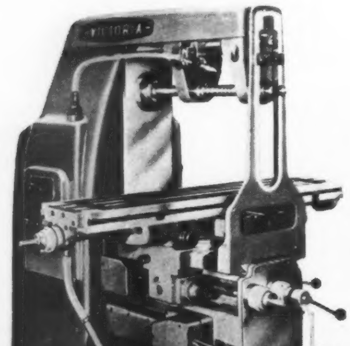
Davis Road, Chessington, Surrey. Phone: Elmbridge 5333 (3 lines)

ELLIOTT VICTORIA *Rapidmil* MILLING MACHINES

- 48" × $11\frac{5}{8}$" table
- 32" longitudinal traverse
- Power feeds and rapid traverses in all directions
- 12 spindle speeds 30 - 1,050 r.p.m. or 43 - 1,500 r.p.m.
- 18 table feeds 0.65 - 15 in./min. or 0.93 - 21.5 in./min.
- 6 h.p. motor
- Backlash eliminator standard equipment



MODEL No. 2



- 48" × $11\frac{5}{8}$" table
- 32" longitudinal traverse
- Power feeds and rapid traverses in all directions
- 12 spindle speeds 30 - 1,050 r.p.m. or 43 - 1,500 r.p.m.
- 18 table feeds 0.65 - 15 in./min. or 0.93 - 21.5 in./min.
- $7\frac{1}{2}$ h.p. motor
- Backlash eliminator standard equipment
- $1\frac{1}{4}$" diameter Arbor
- Spindle Taper No. 50 IST

MODEL No. 2H

Manufactured by:

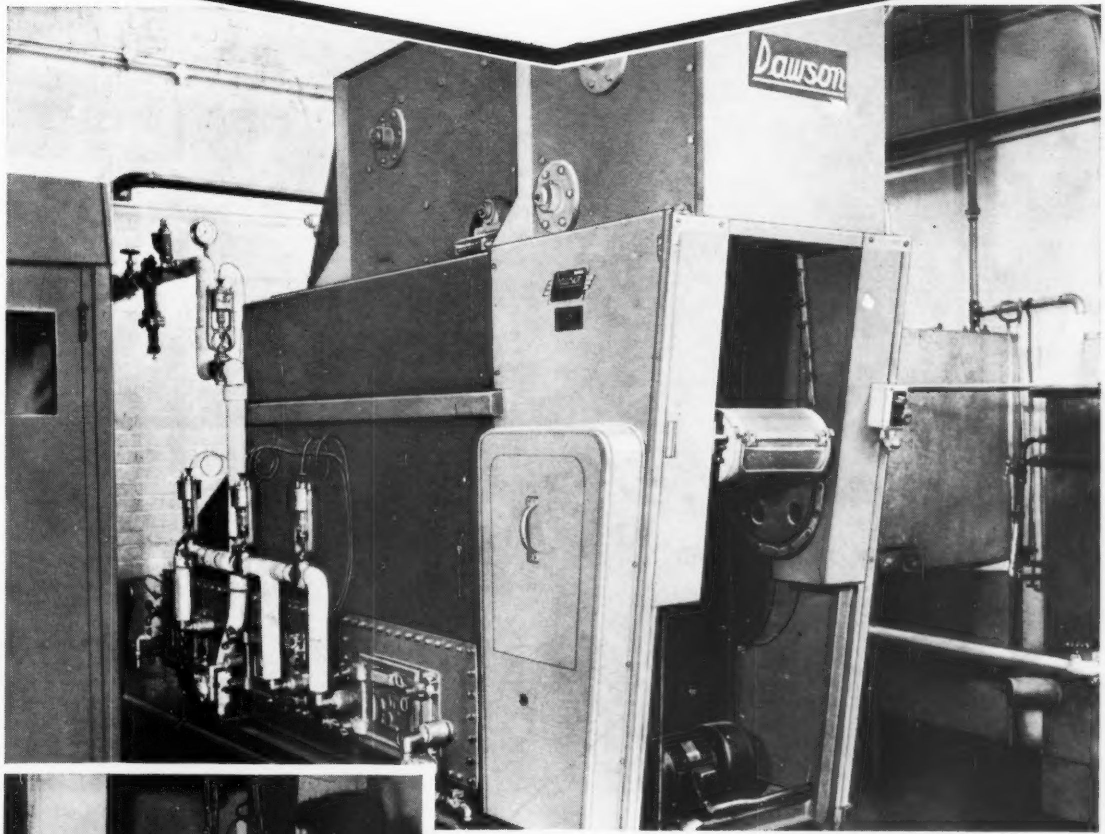
B. ELLIOTT (MACHINERY) LTD.
VICTORIA ROAD · LONDON · N.W.10
TELEPHONE: ELGAR 4050 (14 LINES) TELEGRAMS: ELLIOTTONA, LONDON, NW10

Overseas Subsidiaries: AUSTRALIA · CANADA · SOUTH AFRICA · USA · SOUTH AMERICA

ELLIOTT OF LONDON GROUP

NRP 9053

DAWSON Automatic Solvent Degreasing Plant
at MALLORY BATTERIES LTD. Dagenham



The Operator is seen loading the battery cases into one of the rotating baskets attached to the continuous conveyor of the machine.

Photographs by kind permission of Mallory Batteries Ltd.

At Mallory Batteries Ltd., in Dagenham a vital necessity in the mass production of the miniature batteries for deaf aids and similar compact applications is that the cases should be completely clean before assembly. This important function is carried out by a Dawson automatic Solvent Degreasing Machine. The cases are carried through an automatically timed and controlled double immersion/vapour treatment in rotating baskets attached to a continuous conveyor. The gentle tumbling action ensures that none of the cases escape the powerful degreasing effect of the solvent. On emerging from the machine they are clean, dry and completely odourless.

This machine is of the return type, the parts being loaded and unloaded at the same end by one operator.

For full details of Dawson continuous operation and batch operation solvent degreasing equipment get in touch with Drummond-Asquith Limited.

Dawson

METAL DEGREASING and PRE-TREATMENT PLANT

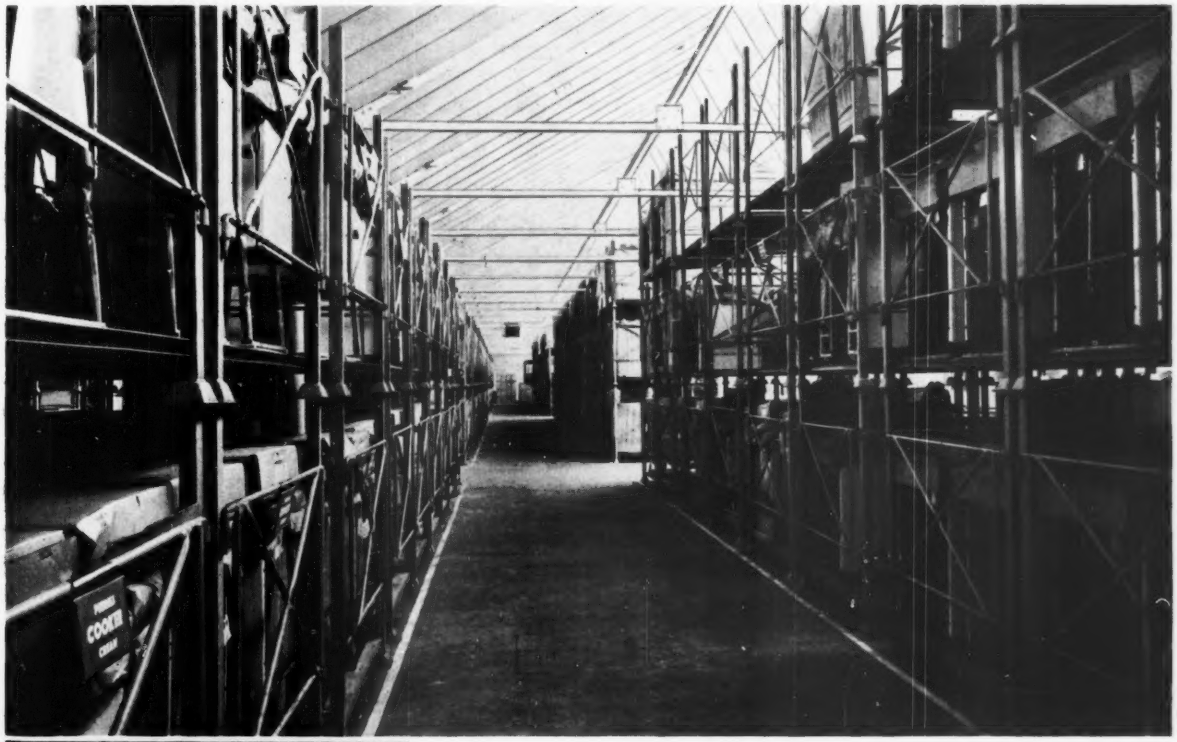
Sole Distributors
DRUMMOND – ASQUITH LTD.
King Edward House, New St. Birmingham
Tel. Midland 3431

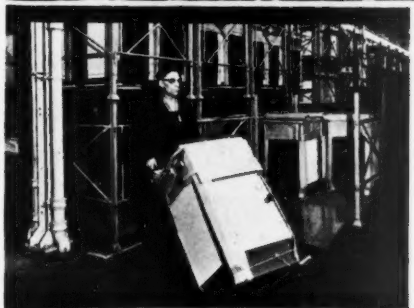
Manufacturers: **DAWSON BROS. LTD., Gomersal, Near Leeds.** **Tel: Cleckheaton 3422 (7 lines).**
LONDON WORKS, 406 Roding Lane South, Woodford Green, Essex. **Tel: Crescent 7777 (4 lines).**

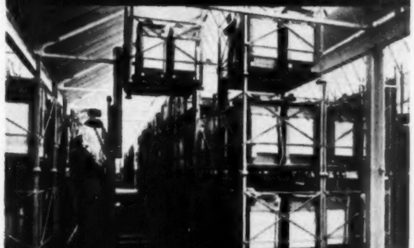
R. O. PALLETS

SPEED SERVICE

FOR THE SOUTH EASTERN GAS BOARD







Palletisation comes into its own in every field of distribution. This is exemplified by the South Eastern Gas Board with this efficient warehouse system at their depot in Old Kent Road, speeding delivery of gas appliances to the customers and cutting time and labour costs for the Board. Successes of this size and scope are further proof that Rubery Owen have the facilities to solve every storage and handling problem.

Perhaps yours ?

Pallets supplied to the South Eastern Gas Board are post type with a removable gate for access and accommodate 4 cookers.

RUBERY OWEN

A complete service in materials handling

Pallet Racks, Work Pans, Storage Equipment, Industrial Flooring

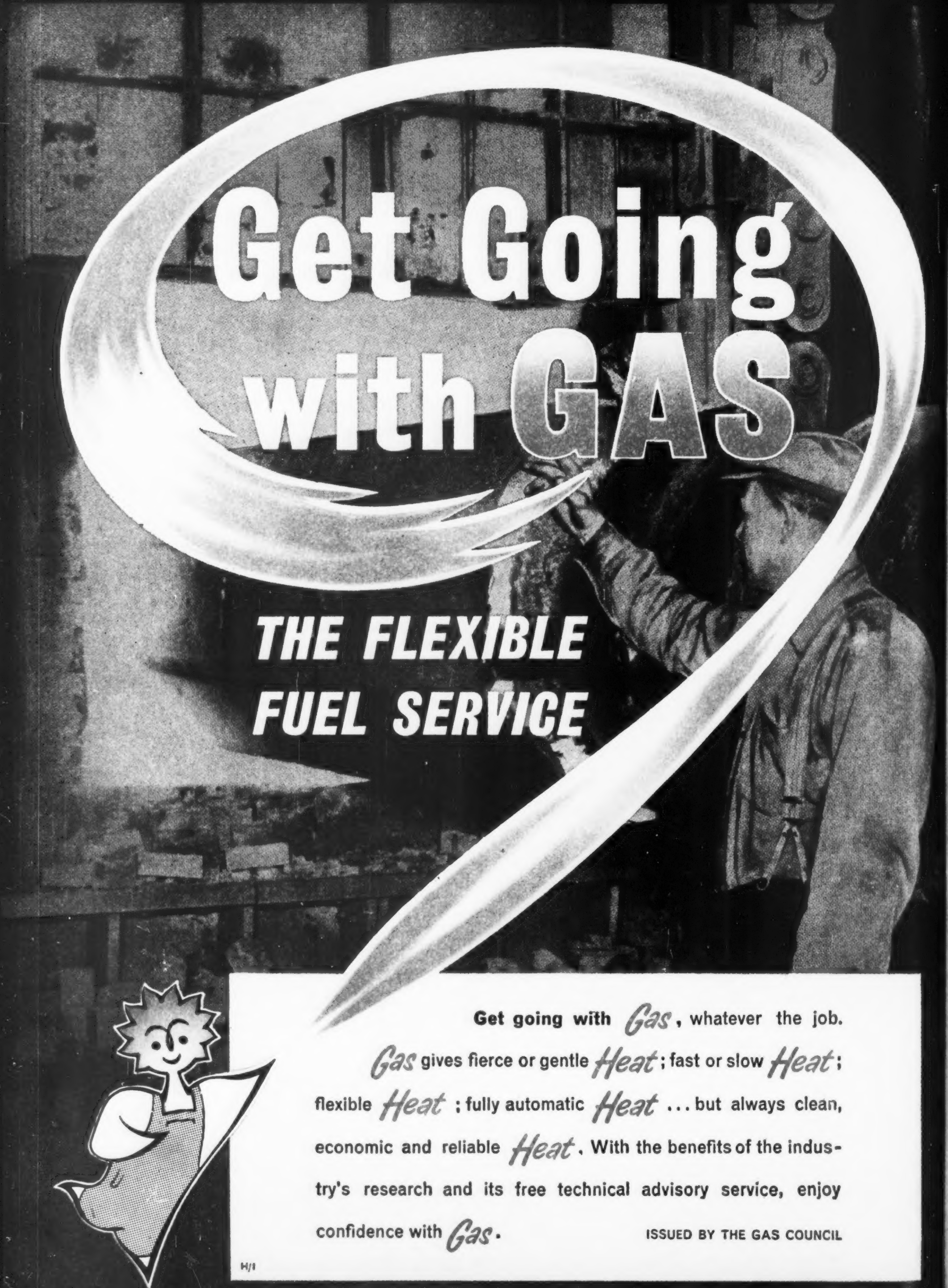
Rubery Owen & Co. Ltd., Industrial Storage Equipment Division, Whitegate Factory, Wrexham, N. Wales. Tel. Wrexham 3566/8

London Office: Kent House, Market Place, Oxford Circus, London, W.1 Tel. Museum 8901 *Member of the Owen Organisation*

INDEX TO ADVERTISEMENTS

Please note that all advertisement pages are prefixed with the letter "A"

All communications regarding advertisements should be addressed to the Advertising Managers, T. G. Scott & Son, Ltd., 1 Clement's Inn, London, W.C.2. Telephone · HOLborn 4743.
Printed by Maxwell, Love & Co. Ltd., 309 - 317 Borough High Street, London, S.E.1.


Get Going with GAS
THE FLEXIBLE FUEL SERVICE
Get going with Gas, whatever the job. Gas gives fierce or gentle Heat; fast or slow Heat; flexible Heat; fully automatic Heat ... but always clean, economic and reliable Heat. With the benefits of the industry's research and its free technical advisory service, enjoy confidence with Gas.
ISSUED BY THE GAS COUNCIL
H/1